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# ENGINEERING:

## An Illustrated Weekly Journal.

*EDITED BY WILLIAM H. MAW AND ALEX. RICHARDSON.*

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Steam Road Rollers & Tractors. 1108

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CULVER STREET WORKS, COLCHESTER.
On Admiralty and War Office Lists.
ENGINES for Torpedo Boats, Yachts, Launches.
BOILER FEED PUMPS.
See advertisement page 18.
PATENT WATER-TUBE BOILERS.
AUTOMATIC FEED REGULATORS.
And Auxiliary Machinery as supplied to the Admiralty. 2179

**Dredging Plant**
OF ALL DESCRIPTIONS.
FLOATING CRANES, COAL BUNKERING VESSELS.
Werf Conrad, HAARLEM, HOLLAND.
Agents: MARINE WORKS, Ltd., Friars House, 39-41, New Broad St., LONDON, E.C. 2.
*See half-page Advert. last week and next week.* 1389

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GEORGE RUSSELL & CO., LTD., Motherwell. 1137

STEEL TANKS, PIPES, GASHOLDERS, &c.
**Thos. Piggott & Co., Limited,**
BIRMINGHAM. 1241
See Advertisement last week, page 82.

**Spencer-Hopwood & Kirke**
PATENT BOILERS 1293
*See Page 84.*
Sole Makers: SPENCER-BONECOURT, Ltd., Parliament Mansions, Victoria St., London, S.W.

**Tank Locomotives.**
Specification and Workmanship equal to Main Line Locomotives.
R. & W. HAWTHORN, LESLIE & CO. Ltd., Engineers, Newcastle-on-Tyne. 1133

**Cochran Boilers.**
MULTITUBULAR AND CROSS-TUBE TYPES.
See page 17. 1134

**E. J. Davis, M.I.Mech.E.,**
Gas Engines Inspected, Tested and Reported upon. Over 25 years' experience. Tel.: 736 and 737 Stratford. Wire: "Rapidising, London." —Great Eastern Road, Stratford, E.15. 1794

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*BUTTERWORTH BROS., Ltd.,*
*Newton Heath Glass Works,*
*Manchester.* Od 9753

**Patents and Trademarks:—**
Inventors Advise, Handbook and Consultations free.—KINGS PATENT AGENCY, LTD. (B. T. King, Director), 146a, Queen Victoria Street, London. 35 years' refs. 1909

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SPECIALISTS
in the
SALE AND VALUATION
of
PLANT AND MACHINERY
and
ENGINEERING WORKS.
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Sole Licensees in Great Britain for the manufacture of "Armco" Rust and Corrosion Resisting Iron Tubes. 817

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Head Office: 34, Robertson Street, Glasgow.
See Advertisement, page 67, July 20.

**YARROW & CO. (1922), LTD., GLASGOW.**
PASSENGER AND CARGO STEAMERS,
SHALLOW DRAFT VESSELS. 1553

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Worm Wheels cut up to 12 ft. diam.
Bevel and Mitre Wheels planed up to 3 ft. diam.
Spur Wheels cut up to 9 ft. diam.
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The Strongest Chain in the World.
Sole Manufacturers: WELDLESS CHAINS, Ltd., 50, Wellington Street, GLASGOW. 898

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*Systems*
PRESSURE, AIR, STEAM
*For Boilers of all types.*
KERMODES LIMITED,
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*Naval Outfits a Speciality,* also for Merchant Ships, for Factories, Locomotives, and Industrial Process Furnaces of all kinds.
Supplied to the British and other Governments.
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Telegrams: "Warmth." 4578

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designed and constructed by
MANNING, WARDLE AND COMPANY, Limited, Boyne Engine Works, Leeds. Od. 2487
See their Illus. Advertisement, page 87, last week.
RAILWAY AND TRAMWAY ROLLING STOCK.
**Hurst, Nelson & Co., Ltd.**
The Glasgow Rolling Stock and Plant Works, Motherwell. Od 3383

**R. Y. Pickering & Co., Ltd.**
(Established 1864.)
BUILDERS of RAILWAY CARRIAGES & WAGONS
MAKERS of WHEELS and AXLES of all kinds.
RAILWAY WAGONS FOR HIRE.
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London Office: Od 8353
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AUCTIONEERS, VALUERS AND SURVEYORS
for
ENGINEERING AND ALLIED TRADES
and
INDUSTRIAL PROPERTIES. 9866
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QUEEN'S WHARF, HAMMERSMITH, W.
Undertake SPECIAL MACHINE WORK of any description.
WELL EQUIPPED SHOP.
LATHE WORK up to 10 ft. diameter.
*Phone:* Hammersmith 31, 967. 9211

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STAMPINGS,
for all Trades,
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Eccles, Manchester.
Tel.: 334 Eccles. 1568

**Power and Speed of Vessels.**
—Practical Course of Instruction by Correspondence.—Address, for particulars and terms, 1463, Offices of Engineering.

**John Bellamy, Limited,**
MILLWALL, LONDON, E. 1316
General Constructional Engineers,
Boilers, Tanks, & Mooring Buoys
Stills, Petrol Tanks, Air Receivers, Steel Chimneys, Riveted Steam and Ventilating Pipes, Hoppers, Special Work, Repairs of all kinds.

IRON & STEEL
**Tubes and Fittings**
AND
**Steel Plates.**
**Stewarts and Lloyds, Ltd.**
GLASGOW - BIRMINGHAM - LONDON.
See Advertisement, page 92. 1111

**Peter Brotherhood Ltd.,**
PETERBOROUGH.
STEAM ENGINES AND TURBINES.
GAS AND OIL ENGINES.
AIR COMPRESSORS.
REFRIGERATING PLANT. 1475
See Advertisement, page 51, July 20.

**Gearing for Power Transmission.**
Including Machine Moulded GEAR WHEELS up to 10 feet dia.;
FLY WHEELS (rope or spur drive) up to 28 feet dia.;
IRON CASTINGS up to 15 tons each, in Loam, Dry or Green Sand;
ENGINES: "Uniflow" "Corliss" or Drop Valve.
BREAKDOWN Repairs a speciality.
CLAYTON, GOODFELLOW & CO., LTD., Atlas Works, BLACKBURN. 1349

**The Glasgow Railway Engineering Company,**
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Manufacturers of
RAILWAY CARRIAGE, WAGON & TRAMWAY WHEELS & AXLES.
CARRIAGE & WAGON IRONWORK, also CAST-STEEL AXLE BOXES. 1234

MACHINE CUT
**Gears**
Spur and Spiral.
Worms and Worm Wheels.
STORR & EVANS,
Grove Road, Hunslet, Leeds. 1573

**Patents** DESIGNS AND TRADE MARKS IN ALL COUNTRIES.
E. P. Alexander & Son,
Chartered Patent Agents,
308, HIGH HOLBORN, LONDON, W.C.
(Established 1874.)
Telephone: Central 7424. Od 585

**Cement.—Maxted & Knott,**
Ltd., Consulting Cement Engineers, ADVISE GENERALLY on proposed Cement Schemes FOR ENGLAND AND ABROAD. ADVICE ONLY. Highest References. Established 1899.
Address, Burnett Avenue, Hull.
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SPECIAL MACHINERY, try—
THOMAS HUNT & SONS,
Albion Ironworks,
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Carels Diesel & Steam Engines (London), Ltd., Carlton House, Regent Street, London, S.W. 1.
Telephone: Regent 3484.

**Royles Limited,**
ENGINEERS, IRLAM, MANCHESTER.
FEED WATER HEATERS, CALORIFIERS, EVAPORATORS, CONDENSERS, AIR HEATERS, } ROW'S PATENTS.
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SYPHONIA STEAM TRAPS, REDUCING VALVES
High-class GUNMETAL STEAM FITTINGS.
WATER SOFTENING and FILTERING. 8723

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LAND AND MARINE
YARROW BOILERS. 1553

**Matthew Paul & Co., Ltd.,**
Levenford Works, Dumbarton. 1483
See Full Page Advt., page 59, July 20.

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**Walter Somers, Limited,**
HALESOWEN. 7116

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For Production of SHEET METAL WORK, COINAGE, CARTRIDGES AND GUNPOWDER.
Foundry, Works, and Showrooms: BIRMINGHAM.
See advert., page 10, July 20. 8195

"Delta" Brand HIGH-CLASS ENGINEERING ALLOYS.
Forgings, Castings, Bars, Sheets, Wire, Tubes.
THE DELTA METAL CO., Ltd., 1234
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T. SUMMERSON & SONS, LIMITED, Darlington. 1219

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**D.B.S. GEARS**
of every description. 1440

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Specifications or Sketches.
GENERAL ARRANGEMENT, DETAIL AND PATENT DRAWINGS undertaken by QUALIFIED ENGINEERS.
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THE SOUTHERN DRAWING OFFICE,
40, St. Andrews Road,
Southsea. B 180

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London Office: 101, Leadenhall St., E.C. 3.
Works: Burnt Mill, near Harlow, Essex.
Makers of
Evaporating and Distilling Plants.
Refrigerating and Ice-making Machinery.
Feed Water Heaters.
Evaporators.
Fresh Water Distillers.
Main Feed Pumps.
Combined Circulating and Air Pumps.
Auxiliary Surface Condensers.
&c., &c. 1586

**Centrifugals.**
**Pott, Cassels & Williamson,**
MOTHERWELL, SCOTLAND. 939
See half-page Advertisement, page 67, July 6.

## The Manchester Steam Users' Association.

For the prevention of Steam Boiler Explosions and for the attainment of Economy in the Application of Steam. 9, MOUNT STREET, MANCHESTER.
Chief Engineer: C. E. STROMEYER, M.I.C.E.
Founded 1854 by Sir WILLIAM FAIRBAIRN.
Certificates of Safety issued under the Factory and Workshops Act, 1901. Compensation for Damages and Liabilities paid in case of Explosions. Engines and Boilers inspected during construction. 1311

## University of Birmingham.

DEPARTMENT OF METALLURGY.

PROFESSOR: THOMAS TURNER, M.Sc., A.R.S.M., F.I.C.

LECTURERS AND DEMONSTRATORS:
T. G. BAMFORD, M.Sc.
HAROLD HARRIS, M.Sc.
T. H. TURNER, M.Sc.

The Course of study covers three years and leads to the Degree of B.Sc. in Metallurgy. There are separate courses for Metallurgists and Metallurgical Chemists. Special attention is devoted to Iron and Steel, Copper, Brass, and Local Industries, and to preparation for Colonial and Foreign posts.
Research and other Scholarships.
For particulars apply to the REGISTRAR. B 176

## Finsbury Technical College,

LEONARD STREET, CITY ROAD, E.C. 2.

CIVIL AND MECHANICAL ENGINEERING.
Professor H. P. PHILPOT, A.M.Inst.C.E.
ELECTRICAL ENGINEERING.
Professor W. H. ECCLES, D.Sc., F.R.S.
CHEMISTRY.
Professor A. G. HALE, F.I.C.

The College provides practical scientific training for students who desire to become Civil, Mechanical or Electrical Engineers or Chemists.
Candidates are required to pass an Entrance Examination in Mathematics and English, but the Matriculation Certificate of any British University, and certain other qualifications, are accepted in lieu of it. The next Entrance Examination will be held on Tuesday, 18th September. Applications for admission should be forwarded to the College on forms to be obtained from the REGISTRAR. The Programme of the College may be had on application. B 47

## The Yarrow Scholarships.

The COUNCIL of the INSTITUTION OF CIVIL ENGINEERS are PREPARED to CONSIDER APPLICATIONS for NOMINATIONS to the above SCHOLARSHIPS.
These should be submitted before the 1st October, 1923, to the SECRETARY of the Institution, at Great George Street, Westminster, S.W. 1, from whom the detailed regulations may be had on application.
The Yarrow Scholars must be British subjects who, desiring to become Engineers, lack sufficient means to enable them to pursue their practical or scientific training.
The Scholarships are of a value varying from £50-£100 per annum. B 162

## Correspondence Courses for

Inst. Civil Engrs., Inst. Mech. E., London Univ. (Matric., Inter., B.Sc.), and All ENGINEERING EXAMINATIONS personally conducted by Mr. TREVOR W. PHILLIPS, B.Sc. (Honours), Assoc. M.Inst.C.E., M.N.S.I., F.R.S.A., &c. Also Day Tuition in Office. Excellent results at all Exams. Courses may commence at any time, and all Students receive individual tuition.—For full particulars apply to 8/11, TRAFFORD CHAMBERS, 58, SOUTH JOHN STREET, LIVERPOOL. 1296

## Engineering Salesmanship

and SALES MANAGEMENT.—Write for brochure describing our special Course of training for posts of unlimited scope in this lucrative field.—DIRECTOR, Institute of Engineering Salesmanship, 333, Oxford Road, Manchester. 1587

## TENDERS.

## The Director-General,

INDIA STORE DEPARTMENT, Branch No. 15, Belvedere Road, Lambeth, S.E. 1, requires:—
1. LOCOMOTIVE ENGINES and TENDERS.
2. WHEELS, Chilled Cast Iron.
Tenders due on the 24th August, 1923.
Tender Forms obtainable from above. B 188

### SALFORD BOARD OF GUARDIANS.

Union Infirmary, Stott Lane, Pendleton, near Manchester.

The Guardians invite

## Tenders for New Lancashire

BOILER, ECONOMISER, FEED PUMPS, STEAM and WATER PIPES, etc., in connection with the Laundry and extensions to the heating and hot water system at the Union Infirmary.
Drawing of the plant and detailed specification of the new boiler may be inspected at the offices of the Engineer, Mr. T. ROLAND WOLLASTON, M.I.Mech.E., Lord's Chambers, 26, Corporation Street, Manchester. Form of Tender, General Specification and Conditions of Contract may be obtained from me on receipt of cheque for Two guineas, which will be refunded upon receipt of *bona fide* Tender.
The Guardians do not bind themselves to accept the lowest or any Tender, and the selected Contractor will be required to subscribe to the Conditions as regards employment of labour, etc., as set forth in their regulations.
Sealed Tenders endorsed "Engineering, Section 1," must be delivered at my offices not later than Ten a.m. on Saturday, August 4th, 1923.
By Order,
R. H. INCHLEY,
Clerk to the Guardians.
Poor Law Offices,
Eccles New Road,
Salford.
17th July, 1923. B 139

### COUNTY BOROUGH OF GRIMSBY.

ELECTRICITY DEPARTMENT.

The Corporation are prepared to receive

## Tenders for the following:—

SPECIFICATION No. 176—HIGH PRESSURE TURBINE, GENERATOR and CONDENSING PLANT.
The Specification comprises:—
One 3,000 Kw. Continuous rated turbo alternator set, with condenser, motor driven auxiliaries, interconnecting pipework, &c.
Specifications and Drawings may be obtained from the undersigned, and extra copies of same may be obtained on the payment of 7s. 6d.
Tenders are to be despatched so as to arrive not later than Tuesday, September 4th.
W. A. VIGNOLES,
Borough Electrical Engineer.
Corporation Electricity Works,
Grimsby.
July, 1923. B 203

### URBAN DISTRICT COUNCIL OF ENFIELD.

The Council invite

## Tenders for the Supply and

DELIVERY to their Sewage Works, Cuckoo Hall Lane, Lower Edmonton, of a Standard VERTICAL BOILER of approximately 6 HP. capacity, with two cross tubes, and suitable for a working pressure of 60 lbs. per square inch.
The boiler is to be complete with all usual fittings and mountings, including Mild Steel Chimney and damper, and is to be delivered within one month of the date of acceptance of Tender. The successful tenderer will be required to enter into a formal indenture of Contract for the due fulfilment of same.
Sealed Tenders, endorsed "Tender for Boiler," and including complete specification of the boiler, are to be delivered to the undersigned not later than Twelve noon on Monday, August 13th, 1923.
T. W. SCOTT,
Clerk to the Council.
Public Offices,
Enfield, Middx.
19th July, 1923, B 175

### THE GREAT INDIAN PENINSULA RAILWAY COMPANY.

The Directors are prepared to receive

## Tenders for the Supply of

the following STORES, namely:—

| | Fee for Specification. |
|---|---|
| CARRIAGE UNDERFRAMES with 4-wheel bogies (66ft. over Headstocks) | ... £1 |

Specifications and Forms of Tender may be obtained at this office on payment of the fee for the Specification, which payment will not be returned.
The fee should accompany any application by post. Cheques and Postal Orders should be crossed and made payable to the Great Indian Peninsula Railway Company.
Tenders must be delivered in SEPARATE ENVELOPES, sealed and addressed to the undersigned, marked "Tender for Carriage Underframes (66ft. over Headstocks)," not later than Eleven o'clock a.m., on Tuesday, the 14th August, 1923.
The Directors do not bind themselves to accept the lowest or any Tender.
R. H. WALPOLE,
Secretary.
Company's Offices,
48, Copthall Avenue, E.C. 2.
London, 23rd July, 1923. B 191

### IRISH FREE STATE.

HAULBOWLINE DOCKYARD.

The Government of the Irish Free State are prepared to consider

## Offers for the Lease of the

above NAVAL DOCKYARD, situated at the entrance to Cork Harbour, and containing extensive Wharf and Warehouse accommodation, with large Dry Dock and Slip-ways. The yard is provided with 60-ton Shear Legs, Travelling Cranes, and well-equipped Machine Shops.
There are also three 5000 ton Oil Tanks and one 6000 ton Oil Tank, which would be disposed of separately.
Specifications, Drawings and particulars may be obtained from
J. F. CROWLEY & PARTNERS,
Consulting Engineers,
16, Victoria Street,
Westminster.
Offers, which should indicate the employment that would be afforded, should reach the above not later than August 25th. The Government do not bind themselves to accept the highest or any Offer. B 120

### COUNTY OF LONDON.

The London County Council invites

## Tenders for the Manufacture,

SUPPLY, DELIVERY, ERECTION, TESTING and MAINTENANCE of MACHINE TOOLS for the Council's Tramway Central Repair Depot, Charlton, London, S.E.
The Specification and Drawings, Form of Tender and other particulars may be obtained from the General Manager, London County Council Tramways, Victoria Embankment, W.C. 2, upon payment of a deposit of £2. This amount will be returnable only if a *bona fide* Tender is submitted and not withdrawn.
Particulars of the work may be obtained at the Tramway Offices, Victoria Embankment, before the payment of the deposit.
Tenderers may submit a Tender for all or any of the machines enumerated in the specification and schedules, and the Council reserves the right to accept any Tender as regards all or any of the items, but does not bind itself to accept any Tender in whole or in part.
Tenders must be addressed to the Clerk of the Council and delivered at the County Hall, Westminster Bridge, S.E. 1, not later than Four p.m. on Monday, 17th September, 1923. No Tender received after that time will be considered.
JAMES BIRD,
Clerk of the London County Council. B 169

### STATE ELECTRICITY COMMISSION OF VICTORIA.

TENDERS FOR PLANT.

## Tenders are Hereby In-

vited for the SUPPLY, DELIVERY, etc., of the following for the Morwell Power Scheme.
Copies of Tender Form and Specification will be available upon application to:—
AGENT-GENERAL FOR VICTORIA,
Melbourne Place, Strand,
London, W.C. 2.

SPECIFICATION No. 23/117—
22,000 VOLT INSULATORS.

CHARGE:—£2 2s. for the first three copies of Tender Form, Conditions of Contract, Specification, complete. These charges will be returned on receipt of a *bona fide* Tender. A fourth copy and any further copies will be supplied for the sum of 10s. 6d. each.
PRELIMINARY DEPOSIT:—A Preliminary Deposit of £50 is to be lodged with the Tender.
The Specification may be inspected at the above-mentioned office.
The Commission does not bind itself to accept the lowest or any Tender.
Tenders on prescribed form, properly endorsed and addressed, must be delivered to the undersigned, in Melbourne, not later than Noon on 6th October, 1923.
R. LIDDELOW,
Secretary,
State Electricity Commission of Victoria,
Melbourne, Victoria,
Australia. B 123

### BY ORDER OF THE RECEIVER.

## For Sale by Public Tender,

subject to conditions which are attached to the Printed Particulars of Sale.
THE WORKS, PLANT, EQUIPMENT, STOCK AND BUSINESS
of
THE UNITED BRASSFOUNDERS AND ENGINEERS LIMITED.
comprising
Several Model Works recently laid out or modernised for the efficient production of valves, taps, gauges, plumbers' fittings and various brasswork, viz.:
LOT 1.
ORMSKIRK, LANCASHIRE.—Recently erected freehold Factory about 8400 sq. yds. floor space, including handsome administrative block and vacant land for large extensions, Seven Dwelling-houses (Three Freehold and Four Leasehold) and Excellent Equipment of Machine Tools, Foundry and Rodding Plant, Loose Tools, Patterns, &c., Electric Power and Lighting generated from own Gas Engines.
LOT 2.
HALIFAX, YORKSHIRE.—Modern Works about 7400 sq. yds. floor space, with Offices and Canteen. Valuable well laid out Machine Tools and Foundry Plant, Loose Tools, Patterns, &c. Electric Power and Lighting from Corporation.
LOT 3.
WOODCHESTER, GLOUCESTERSHIRE.—Excellent Works, mainly erected from 1916 to 1919, with Offices and Canteen, Six Cottages, Modern Automatic and other Machines for brass and iron taps, Semi-rotary Pumps and Gauges, Foundry Plant, Loose Tools, Patterns, &c. Electric Driving from own Gas Engines and Efficient Water Turbines.
LOT 4.
BIRMINGHAM.—Central premises in Holloway Head, containing about 4500 sq. yds. floor space, including Foundries, Electric Driving, Machines and Equipment for manufacturing plumbers' brass work, sprays, &c.
LOT 5.
MANCHESTER.—Modern premises in Empress Street, Stretford, principally one lofty storey; floor area about 7300 sq. yds. but could be increased by adding floors in certain buildings very suitable for the purpose, extensive Offices and Canteen, Electric Power and Lighting from Council or own Gas Plant. Over 120 Machine Tools and other Plant, 10 Ton Three Motor Crane, Patterns for air compressors, steam traps, pumps and valves.
(This branch has been closed down and will not be sold as a going concern).
LOT 6.
The Goodwill of the business with the Trade Marks.

The Stock-in-Trade at the respective Works, consisting mainly of valves and taps and plumbers' brass fittings; Work in Progress and Raw Materials.
The Receiver is carrying on the business (other than that at Manchester, which has been closed), and the purchaser or purchasers must take over all existing contracts.
Offers may be made as follows:—
(A) For the whole of the properties, stock, goodwill, trade marks and business as a going concern (other than cash, book and other debts, bills receivable, investments and claims for repayment of taxes).
(B) For any one or more of the properties.
(C) For the Trade Marks and Goodwill.
The Offers to be made on a specified form attached to the Printed Particulars and Conditions, and must be delivered to the Receiver at his Offices, 4, Central Buildings, Westminster, London, S.W. 1, not later than Twelve o'clock Noon on the 10th day of August, 1923, envelope to be marked "Tender—The United Brassfounders & Engineers Ltd."
The Receiver does not bind himself to accept the highest or any Tender.
Particulars of the Land, Ground Rents and other Information, Plans of the Buildings, and permits to view the properties, may be had from the Solicitors or Valuers.
Printed Particulars with Conditions and Form of Tender may be had from—
M. WEBSTER JENKINSON, Esq.,
Receiver,
4, Central Buildings,
Westminster,
London, S.W. 1.
Messrs. LINKLATERS & PAINES,
Solicitors,
2, Bond Court,
Walbrook,
London, E.C. 4.
Messrs. F. S. AIREY, ENTWISTLE & CO.,
Auctioneers, Valuers & Fire Loss Assessors,
10, Norfolk Street,
Manchester. B 138

### METROPOLITAN WATER BOARD.

PROVISION OF 7-TON STEAM CRANE—LEA BRIDGE, CLAPTON, N.E.

The Metropolitan Water Board invite

## Tenders for the Supply,

TESTING and SETTING TO WORK of a STEAM DRIVEN LOCOMOTIVE SHUNTING JIB CRANE, of 7-tons capacity, at their Lea Bridge Pumping Station.
Forms of Tender and Conditions of Contract may be obtained on and after Saturday, 21st July, 1923, from the Chief Engineer, New River Head, 173, Rosebery Avenue, E.C. 1., by personal application (Room 155) or upon forwarding a stamped addressed brief envelope.
Tenders, enclosed in sealed envelopes, addressed to "The Clerk of the Board, Metropolitan Water Board, New River Head, 173, Rosebery Avenue, E.C. 1." and endorsed "Tender for Crane," must be delivered at the Offices of the Board not later than Eleven a.m. on Friday, 10th August, 1923.
The Board do not bind themselves to accept the lowest or any Tender.
G. F. STRINGER,
Clerk of the Board.
Offices of the Board,
New River Head,
173, Rosebery Avenue, E.C. 1.
20th July, 1923. B 193

### CLYDE NAVIGATION.

TO ROAD AND BRIDGE CONTRACTORS.

The Trustees of the Clyde Navigation invite

## Tenders for the Construction

of about 3,000 lineal yards of MAIN ROAD, including the laying of Tramways thereon, forming a DIVERSION of the RENFREW ROAD between Maxwell Road, Shieldhall, and Millburn Bridge, Renfrew, with Three Reinforced Concrete BRIDGES carrying the New Road, over existing and intended lines of railway.
The Drawings may be seen and Specification, Schedule of Quantities and Form of Tender obtained on and after Friday, 27th curt., by application to the Trustees' Engineer, at his Office here, on deposit of Five Guineas, which will be returned on receipt of a *bona fide* Tender.
An Assistant Engineer will be in attendance at Maxwell Road, Shieldhall, at Ten a.m. on Wednesday, 1st August, to point out to intending Offerers the location of the works.
Sealed Tenders, marked "Tender for Renfrew Road Diversion," are to be lodged with the undersigned not later than Noon on Monday, 20th August.
The Trustees do not bind themselves to accept the lowest or any Tender, and they reserve power to divide the work into two or more separate Contracts to different Contractors.
T. R. MACKENZIE,
General Manager and Secretary.
16, Robertson Street,
Glasgow, 24th July, 1923. B 199

### THE BENGAL AND NORTH WESTERN RAILWAY COMPANY, LIMITED.

The Directors are prepared to receive

## Tenders for the Supply of:—

101 TONS RED AND WHITE LEAD, dry, as per specification to be seen at the Company's Offices.
Tenders addressed to the undersigned, and marked "Tender for Red and White Lead," with name of firm tendering, are to be lodged not later than Noon on Friday, the 10th day of August, 1923.
For each Specification a fee of 10s. will be charged which cannot, under any circumstances, be returned.
The Directors do not bind themselves to accept the lowest or any Tender.
By Order of the Board,
E. A. NEVILLE,
Managing Director.
237, Gresham House, Old Broad Street,
London, E.C. 2.
25th July, 1923. B 216

### COUNTY OF LONDON.

The London County Council invites

## Tenders for Piping, Valves,

etc., for the Northern Outfall Works, East Ham, E. 6 (alongside Beckton Gasworks).
Persons desiring to submit Tenders may obtain on and after Monday, 30th July, 1923, the Drawings, Specification, Form of Tender, etc., on application to the Chief Engineer, at the Old County Hall, Spring Gardens, S.W. 1., upon payment of the sum of £2. This amount will be returnable only if the tenderer shall have sent in a *bona fide* Tender and shall not have withdrawn the same. Full particulars of the work may be obtained on personal application, and the drawings, specification and other contract documents may be inspected at the Old County Hall before payment of the fee.
No Tender received by the Clerk of the Council at the County Hall, Westminster Bridge, S.E. 1, after Four p.m. on Monday, 13th August, 1923, will be considered.
The Council does not bind itself to accept the lowest or any Tender.
JAMES BIRD,
Clerk of the London County Council.
B 214

### GREAT NORTHERN RAILWAY (IRELAND).

PERMANENT WAY MATERIALS.

The Directors are prepared to receive

## Tenders for the Supply of:—

90 lb. R.B.S. BULLHEAD RAILS, and Fish-plates for same,
CAST IRON CHAIRS,
and
PERMANENT WAY FASTENINGS.
Specifications, Drawings and Forms of Tender can be obtained from the Secretary.
Tenders, made out on the Forms supplied by the Company, should be delivered, under sealed cover, endorsed "Tender for Rails, &c.," to the undersigned, not later than Ten a.m. on Saturday, 18th August.
The Directors do not bind themselves to accept the lowest or any Tender.
J. B. STEPHENS,
Secretary.
Secretary's Office,
Amiens Street Station,
Dublin, 24th July, 1923. B 219

## SOUTH KENSINGTON ROYAL SCHOOL OF NAVAL ARCHITECTURE—1864–1873.

FIFTY years ago the above-named school terminated its short existence of nine sessions and was transferred to the Royal Naval College at Greenwich, where it still flourishes, and is as vigorous as ever it was in training naval architects and marine engineers for the Admiralty service. A few words relating to this famous school in this, the jubilee year of its closing, will no doubt be welcomed by our readers. It was the third English School of Naval Architecture, and in order to realise the nature of its origin and its work some slight reference must be made to its two predecessors.

The first of these was established in Portsmouth Dockyard in the early part of 1811. It remained in existence till 1832 and was then closed by the order of Sir James Graham, who was at that time First Lord of the Admiralty. It trained about 40 students. The Rev. Dr. James Inman was the principal of this school and was much respected by all his pupils. One of the best known of these was Mr. Isaac Watts, the Chief Constructor of the Navy from 1847–63. He was responsible for the design and the actual building of the Warrior, and some other famous vessels of the early period of the iron-clad construction of our ships. Messrs. Reade, Chatfield and Creuze, three others of Dr. Inman's pupils, achieved great distinction in the Admiralty service. The latter eventually became chief surveyor to Lloyd's Register of Shipping, in which capacity he did much good work for the mercantile marine. Dr. Inman was a very many-sided man, from whom his pupils learned much in the way of general culture outside the limits of their strictly technical studies. He translated into English the works of Chapman, the famous Swedish naval architect. His book of nautical tables, dealing with the astronomical side of the navigation of H.M. ships, has for many years been the standard work of its kind.

The Second English School of Naval Architecture commenced its work at Portsmouth Dockyard in 1848 under the title of "The Central School of Mathematics and Naval Construction," with the Rev. Dr. Joseph Woolley as its principal. He, like Dr. Inman, soon won the respect of his pupils and did very much for them. This school only continued in existence for five years, and was then closed by the Sir James Graham named above. He evidently did not believe in the necessity for such a school. This second school trained about 20 students on some of whom ultimately fell the responsibility of continuing the Admiralty work of Mr. Isaac Watts, and of collaborating with him and others in founding the South Kensington School of Naval Architecture, the subject of our present remarks. Among these 20 students were Sir Edward Reed, Sir Nathaniel Barnaby, both in their turn chief designers of H.M. ships. There were also Mr. Frederick Kynaston Barnes, Mr. James B. Chessell Crossland and Mr. Henry Morgan, all of whom had for many years high responsibilities at the Admiralty in assisting in the designing and building of many types of H.M. ships.

In the year 1860, was founded the Institution of Naval Architects, in the founding of which Dr. Woolley and the six naval constructors named above took a very prominent part. They were all "original members" of the Institution, and although some of them lived to a good old age, all are now deceased. The value of their work, however, as regards establishing the South Kensington School still remains, and so also does the influence of their brilliant example. This influence had a very marked effect on the South Kensington students. Many of these had the advantage of personal contact with them and to some extent of their work. The Institution, under the continued and well-directed representation of the Admiralty six naval constructors named above, Mr. J. Scott Russell and other members of the profession, and headed by Dr. Woolley and the Right Hon. Sir John Somerset Pakington, president of the Institution, induced the Admiralty to found the South Kensington School.

Sir John Pakington was appointed First Lord of the Admiralty in 1858, in the then Lord Derby's premiership, and during his tenure of this office he ordered the construction of the Warrior, the first sea-going ironclad of the British Royal Navy. After some time spent thereafter in Parliamentary opposition he was, in 1866, again appointed as First Lord of the Admiralty. In the early part of his career he was a powerful advocate of a scheme of national education. His mind was thus by predilection, by his early experience as First Lord of the Admiralty, and by the knowledge he gained as president of the Institution of Naval Architects, well fitted to appreciate the necessity of founding the South Kensington School. It is not too much to say that apart from the technical members of the Institution he did more in high places, than any other, to put this school on the basis that has proved so enduring. All well-informed British naval architects and marine engineers know that they owe him a great debt of gratitude for this work. He died, full of years, as Lord Hampton of Hampton Lovett, after having presided over the Institution for 21 annual sessions.

We now come to the South Kensington School itself. As will be seen from the above, it had most excellent founders. It also had a most excellent directing and teaching staff. Dr. Woolley was appointed as the director of the studies to be carried out. In the work of framing the course of studies he was assisted by Sir Edward Reed, then Chief Naval Constructor. Dr. Woolley had the somewhat curious title of "Inspector General." He took very little part in the actual teaching, but was very active in the preparation of the examination papers set at the end of each session, and in forming the general tone of conduct in the school. He published a work on what he called "Descriptive Geometry," viz., the science of exhibiting on elevation, plan and section the form of any body however complicated it might be. All the principles involved in laying-off ships on the mould loft floor are embodied in this work. The book contained many elegant geometrical theorems bearing on the subject. It was the first work of its kind published in this country, and although it has long been out of print no subsequent similar work has exceeded its merits. It was made one of the standard text books of the school. Dr. Woolley did a great work for the school and for the sciences it was intended to promote. He died in 1889.

The actual teaching in mathematics was carried out by Mr. C. W. Merrifield, a learned barrister and a good mathematician. He was appointed as "principal" of the school. At the time of this appointment he was connected with the Education Department of the Privy Council Office. He returned to that office on the closing of the school in 1873. In the early days of the Institution of Naval Architects he was for some time its Hon. Secretary, and in this and in many other ways he did much to promote the study of the science of naval architecture, especially on its purely mathematical side. He died in 1884, at the early age of 56. He loved the school, and did his utmost for it. Mr. Merrifield very soon resigned his post as principal in favour of Mr. Purkiss, his vice-principal, the Senior Wrangler of his year. Mr. Purkiss was soon after accidentally drowned, and Mr. Merrifield was reappointed as principal in which capacity he continued till the close of the school in April, 1873. Mr. Purkiss was succeeded as vice-principal by Mr. H. M. Taylor, a high wrangler, who retired after a short term of service. He is happily still living as a link with the old school, but is unfortunately quite blind.

Mr. Taylor was succeeded as vice-principal of the school by Mr. J. H. Cotterill, who continued in that post till the school was, in 1873, transferred to the Royal Naval College at Greenwich. He was transferred with it and remained on service there for many years, having the title of "Professor of Applied Mechanics." He published a book on "Applied Mechanics," which was a collection of his class lectures. It is still the leading book on the subject. He also published a book on the "Steam Engine," dealing with the subject mainly from its thermo-dynamical side. He also did much to develop the theory of marine propulsion. On account of his long life, his great ability and untiring energy, and in spite of his lack of robust health, the science of naval architecture and of marine engineering is greatly indebted to him. He died in 1922, in his 86th year.

The students were also taught by other gentlemen, who each had the title of "Instructor." Instruction was given in naval design, practical shipbuilding, marine engineering in all its branches, ship and machinery drawing and in chemistry. Dr. W. C. Unwin was one of this group, and is the only survivor of them.

In addition to the above teaching the students had the advantage of hearing lectures, about twice a week, from gentlemen very high in their respective professions. Among these lecturers were the Astronomer Royal (Sir George Airy) on "Magnetism," particularly in its relation to compass deviation in iron built ships, which was then a very important matter; Sir Edward Reed, Sir Nathaniel Barnaby and Mr. J. Scott Russell; Dr. Percy on "Metallurgy"; Dr. Frankland on "Chemistry"; Sir William Fairbairn, Professor Rankine, Mr. William Froude and Mr. E. R. Allfrey, chief designer of the marine engineering firm of Messrs. Humphrys, Tennant and Co., of Deptford. It is no wonder that Sir William White wrote, fifty years ago, "Speaking generally it may be said that at South Kensington the students had placed within their reach educational advantages not merely surpassing those of either of the previous English Schools of Naval Architecture, but nothing inferior to those anywhere attainable."

The South Kensington School differed from its two predecessors in several respects. In the first place it was, on account of the advent of the steam propulsion of ships a school of marine engineering, in addition to being simply a school of naval architecture as the two former schools were. In the next place it was founded in London instead of conducting its work at a Royal Dockyard. This change of plan was much debated before a decision was reached, but ultimately it was decided and, as experience afterwards proved, very wisely decided, to have the school in London where the students would have the advantage of hearing lectures from eminent scientists whose engagements would not permit them to visit Portsmouth. Having the school in London also had the indirect but very great advantage of introducing the students into a broader atmosphere of life than was existent in a dockyard town with its provincial habits of thought, and these in 1864 were very restricted. The school also differed from its two predecessors in the respect that under certain reasonable regulations non-Admiralty or private students were admitted to the school. Also that as regards the Admiralty students they were to be selected entirely by merit and not as was the case in the first school to some extent by social standing and ability to pay a fee. No Admiralty student of the school was allowed anything in his favour either by parentage or any other personal influence or by the payment of a fee. This procedure has been maintained at Greenwich. Every entry into the school and every success gained in it has always been entirely due to the students' own ability and efforts.

The school commenced its work on November 1, 1864. The students were 20 in number. Eight were Admiralty students of naval architecture, eight were Admiralty students of marine engineering. All these were selected as the result of a competitive examination among the dockyard shipwright apprentices and among the dockyard engineering students. Four were private students of naval architecture. Of the Admiralty students of naval architecture five especially distinguished themselves. Taking them in the alphabetical order of their names they were first Mr. W. J. Bone. After a short period of service at Pembroke Dockyard and as Assistant Overseer of H.M. Shipbuilding by contract he joined Lloyd's Register of Shipping. Shortly thereafter he became general manager of the Tyne Iron Shipbuilding Company, and remained with that firm till his death in 1909. Mr. H. E. Deadman, C.B., was next; he had a very varied experience in the Admiralty service, partly in the oversight of H.M. ships building by contract, partly in the home dockyards and partly abroad, and concluding in the high office of Senior Assistant to the Director of Naval Construction during a period of great changes in the designs of H.M. ships.

We are glad that he is still living, but he is, alas, the only survivor of that notable band.

Next was Dr. Francis Elgar, LL.D., F.R.S., who, after a short period of Admiralty service became in turn assistant to Sir Edward Reed while he was practising as a consulting naval architect, after his retirement from the Admiralty as Chief Naval Constructor. He became the first occupier of the Chair of Naval Architecture and Marine Engineering in the University of Glasgow, general manager of Earle's Shipbuilding and Engineering Company, of Hull, and afterwards the first officer having the title of Director of Dockyards. In this capacity, with the assistance of his colleagues at the Admiralty and the dockyards, chief among the latter being H. E. Deadman mentioned above, he did excellent work in bringing the procedure of the Royal Dockyards into good commercial economical methods in no way inferior to those in the private yards, having regard to the difference of the conditions between the two sets of yards. He then became Director and Consulting Naval Architect to the Fairfield Company at Glasgow, and finally became chairman of Cammell Laird and Co., of Sheffield and Birkenhead, and also of the Fairfield Company. He left a very large benefaction to the Institution of Naval Architects, and founded an Institution scholarship which bears his name. He died in 1909. Then there was Mr. W. John who, after a short period of Admiralty service, became a high officer at Lloyd's Register. While there he did much good work in improving the rules for all matters in connection with the construction of merchant ships, and carried out a valuable investigation "On the Masting of Ships." He left Lloyd's and became general manager of the Barrow Shipbuilding and Engineering Company, and afterwards practised as a consulting naval architect in the City of London. He died at the early age of 45.

There was also Sir William H. White, F.R.S., probably the most widely known of the group. With the exception of a short interval of work with the Armstrong Company, at Newcastle, all his public life was spent in the service of the Admiralty, assisting first Sir Edward Reed and then Sir Nathaniel Barnaby, and then succeeding Sir Nathaniel in the office of Director of Naval Construction, which he occupied from 1885 to 1902. During this period more ships were constructed, more money was spent on naval construction and more changes made in the designs of H.M. ships than in any previous period of the same duration. He was also a great writer, *e.g.*, his "Manual of Naval Architecture." He founded an Institution scholarship which bears his name. He died in 1913.

The first group of the students of marine engineering equally distinguished themselves. Two of them —J. A. Bedbrook, Chief Inspector of Machinery, and W. G. Littlejohns, C.B., Engineer Rear-Admiral— did much important work afloat and in the Royal Dockyards. A third—W. J. Pratten—did much good work for the mercantile marine. He was the founder and for many years general manager of the engine works of Harland and Wolff, at Belfast. We are pleased to say he is still alive.

Space does not admit of a reference in detail to the students of each successive year of entry, but among those of the more prominent of them may be mentioned Mr. L. G. Davies who was for some time Civil Assistant to the Admiral Superintendent Portsmouth Dockyard, which was the highest dockyard appointment open to a shipbuilding officer; Mr. J. R. Perrett, for many years naval designer and general manager of the Armstrong Elswick Shipyard; Mr. F. Prior Purvis (private student), for many years Professor of Naval Architecture at Tokio University; Sir William Smith, who spent all his public life in the service of the Admiralty. He was appointed by Mr. McKenna, then First Lord of the Admiralty, to succeed Sir Philip Watts as Director of Naval Construction on the retirement of that officer from this post. Before Sir Philip's retirement, a new Board of Admiralty was formed, with Mr. Winston Churchill as First Lord, and Sir William's appointment did not mature into actuality. Mr. G. Stanbury, a high officer of Lloyd's Register; Dr. S. J. P. Thearle, chief ship surveyor of Lloyd's Register, and writer of well-known works on naval architecture; Sir Philip Watts, F.R.S., who, after a very varied experience in the Admiralty service in his early life, largely in conducting experiments having as their object the improvement of the designs of H.M. ships, was for many years, and prior to the appointment of Mr. Perrett in that capacity, naval designer and general manager to the Armstrong Elswick Shipyard, and after that was for the period 1902–12 Director of Naval Construction at the Admiralty. During this latter period he designed the "Dreadnought" type of battleship and battle cruiser, light cruisers, flotilla leaders and other craft, all of which types were employed in the Great War of 1914-18, and were so instrumental in our winning it.

Among the marine engineers may be mentioned Mr. R. J. Butler, C.B., for many years Assistant to the Engineer-in-Chief at the Admiralty; Engineer Rear-Admirals W. W. Chilcott, C.B.; and J. T. Corner, C.B. Admiral Chilcott was undergoing medical treatment in Germany at the outbreak of the Great War. On account of his rank he was interned. He died in May, 1915, during internment, and was buried in German soil by the side of his friend Admiral Corner, who died at Bad Mannheim, in Germany, in August, 1912, while he also was on a visit for medical treatment. Engineer Vice-Admiral Sir A. John Durston, for some years Engineer-in-Chief at the Admiralty, during the period of the introduction of the water-tube boiler; Professor T. A. Hearson, for some years on the staff of Cooper's Hill College; Engineer Rear-Admiral R. Mayston, C.B.; Mr. Alfred Morcom, whose name is now embodied in that of the firm of Belliss and Morcom; Mr. A. E. Seaton, now chairman of Belliss and Morcom and also of the Iron Trades Employers' Insurance Association, who was for some years general manager of Earle's Company, at Hull, and who is also well known as a writer of text books on marine engineering. There was also Mr. Richard Sennett, who preceded Sir John Durston as Engineer-in-Chief of the Navy. He resigned this rank in May, 1889, to become a director of Messrs. Maudslay, Sons and Field. He died in September, 1891, at the early age of 44. We are pleased to be able to state that Mr. R. J. Butler, Mr. A. E. Seaton, Sir William Smith and Sir Philip Watts are still actively engaged in professional work.

The school was not so successful with private students as with Admiralty students. The chief reason for this was that the private students on joining the school had not had the same sound preliminary training that the Admiralty students had, and this feature acted as a heavy handicap on them during the whole period of their South Kensington studies. In spite of this handicap, however, some of them achieved considerable distinction. One of these, Mr. F. Prior Purvis, has been mentioned above. There were also M. Constantine Artsayooloff, M. Ernest Goulaeff, naval architects, and M. Nicholas Ivanoff, marine engineer, all three of the Russian Imperial Navy, all of whom rose to high office in their service. Then there was M. Mohammed Anis, an Egyptian who became a Pasha, and who rendered a good service to Egypt and Britain in connection with the surrender of Alexandria after its bombardment in 1882.

It is no part of the object of these notes to make detailed reference to the graduates of the Greenwich School. These have established a high record. It may, however, be said that the very high standard realised at South Kensington has been fully maintained.

For the students of the South Kensington school who entered in 1864 and 1865, the London course of study consisted of three sessions of six months each. Experience gained of the great ability and capacity of these students showed that the London course of study for the succeeding entries could with great advantage be lengthened and the instruction correspondingly increased in scope. In the later years of the school the arrangements provided for four sessions at South Kensington, each of seven months' duration. In all cases the intervening summer months were spent in a Royal Dockyard, during which time the students were not only entirely free, but were encouraged, to inspect any work in progress and to make sketches and written descriptions of such work. These sketches and descriptions had at the end of each month to be forwarded, through the Admiral Superintendent of the Yard, with any of his comments thereon, to the Admiralty. This combination of scholastic work in London with the actual constructive work at the dockyards proved most excellent. It was not only excellent as regards the amount and well-balancing of the knowledge gained thereby, but in addition the outdoor life of the work in the dockyards was a useful corrective of the more indoor life in the London school.

The hours of study at the school were somewhat heroic. From 9 a.m. to 12 noon on each of the six weekdays was spent in the study of mathematics, applied mechanics and kindred subjects. From 2 p.m. to 5 p.m. was spent in practical work on ship and engine designing and drawing, or in practical work in chemistry. On two days in the week, from 5 p.m. to 6 p.m., the students attended a lecture by one of the gentlemen mentioned above. On the two days when there was no such lecture there was a further period of study from 7 p.m. to 9 p.m., during which there was no actual teaching; the time was spent by the students in recapitulating the previous work of the day and in writing up their notes. On the two lecture days the corresponding period was from 7.30 p.m. to 9 p.m. On Wednesdays and Saturdays all school work ceased at noon. These afternoons were generally spent in playing football in Battersea Park. Experience proved that the hours of study were too long, except for those who were the more robust. Several of the students broke down in health on this account, and in consequence during the later period of the school's history attendance in the evening was entirely optional. Some attended, but many remained at home.

The standard of examination at the end of each session was a very high one. Four classes of diploma were awarded. These were graduated in accordance with the success obtained by the students. They consisted of Fellows of the first, second and third class and of Associate. Only ten students gained the first-class of Fellowship and of these only two remain.

The school building was very far from satisfactory. It was not much more than a rough wooden shed often too cold on cold days and too hot on warm days. The school was entirely non-residential, the students had to find their own lodgings and had no corporate social life. In spite of this disadvantage the intensity of the desire of the students to learn as much as possible kept them for the most part unharmed by the temptations, to which young men of their age, for the first time freed from parental and similar oversight, and in London, many miles away from their country homes, could not be entirely free. On the transfer of the school to Greenwich the students had residential quarters allotted to them in the college building. They messed together at the same table, slept under the same roof, and had the advantage of the same naval oversight as was afforded to the junior officers of the Navy.

In conclusion, it must be stated that the South Kensington School did wonders. It had among its graduates not only those named above, but many others whose work was scarcely less distinguished. It set up a standard of teaching and of intensity of study which having regard to its purpose has, we think, never been surpassed. It did its work so well that the Admiralty on the founding of the Royal Naval College at Greenwich had no hesitation in transferring it to that Institution and giving it a fresh start under such favourable conditions as have enabled it to continue to this day as fresh and vigorous as ever it was. It not only did this, but many of its graduates went from the Admiralty service into private employment and demonstrated the great national and commercial value of such an education as they had received. It was largely due to this demonstration falling on fruitful soil that the Glasgow University Chair of Naval Architecture and Marine Engineering was founded. This in time led to a similar chair being founded in Durham University and in Liverpool University, both of which chairs are occupied by graduates of the Greenwich School. The work of the South Kensington School and the natural

growth that followed therefrom has resulted in the founding of many scholarships in naval architecture and marine engineering, and in placing Great Britain in her present high position in all matters relating to these sciences. We think that no greater praise than this can be given.

We would like to add that the great success of the South Kensington School and of its continuation at Greenwich could not have been possible in the time available for study in London had it not been for the work of the dockyard schoolmasters, who have always given their students the very best of preliminary instruction. These gentlemen are not so well known to the public as they deserve to be, Their work has been magnificent and it is being continued as efficiently as ever it was. The first of them was Mr. Robert Rawson, of Portsmouth Dockyard School, who had been a pit-boy in a coal mine. He had no formal education, but he contrived in his early manhood to solve some difficult problems relating to bridge construction, which at that time rendered great service to the bridge engineers. He was appointed the first schoolmaster at Portsmouth Dockyard, and at the time of his appointment had never previously been in a school. His life's work appears in the volumes of the Royal Society, in which are recorded his great skill as a mathematician and the work he did for those placed under his charge.

## CUTTING STEEL PILING BELOW LOW-WATER LEVEL.

By JAMES MITCHELL, M.Inst.C.E., M.I.Mech.E.

A NEW reinforced-concrete pumping station on the north bank of the River Dee, for the supply of condensing water from the river to the electricity generating station of the Aberdeen Corporation, is now nearing completion. It consists, as shown in plan by Fig. 1, of a pump chamber, a sump chamber, and an inlet culvert. The culvert, which extends well into the river, is founded upon a bed of fine sand several feet thick, and when foundation-level was reached, a number of large springs were tapped. The station is situated on the concave bank of a considerable bend in the river, and the river bed in the vicinity of the mouth of the culvert is liable to erosion by the severe floods to which the river is subject.

It thus became advisable to protect the structure of the culvert from the danger of being undermined. The construction of the station has been carried out within a cofferdam of 40 ft. long steel interlocking sheet piling, driven to a depth of about 16 ft. below the bed of the river, and well into a stratum of boulder clay. Various proposals for forming a cut-off round the mouth of the culvert by means of sheet piling were considered, such as driving timber piling outside the steel piling, before the withdrawal of the latter; cutting off the upper portion of the steel piling, by means of a circular saw or a hack saw; partially withdrawing the steel piles, so that they could be cut above water-level, and then driving the lower portions back to their original position, using the upper portion of each pile as a punch, and thereafter removing it. It was finally decided, on the suggestion of the writer, to try to cut the steel piling by means of an oxy-acetylene torch, operated from the interior of the cofferdam, and this work has now been successfully completed.

Fig. 1.

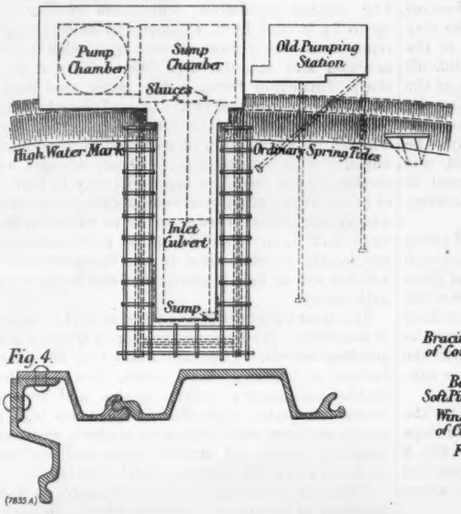



Fig. 4.



Fig. 2.

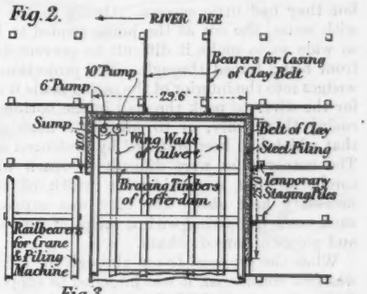
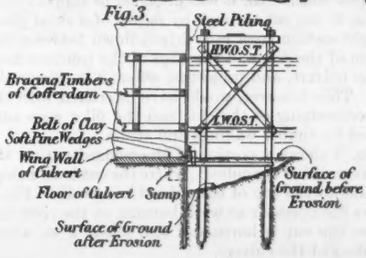



Fig. 3.



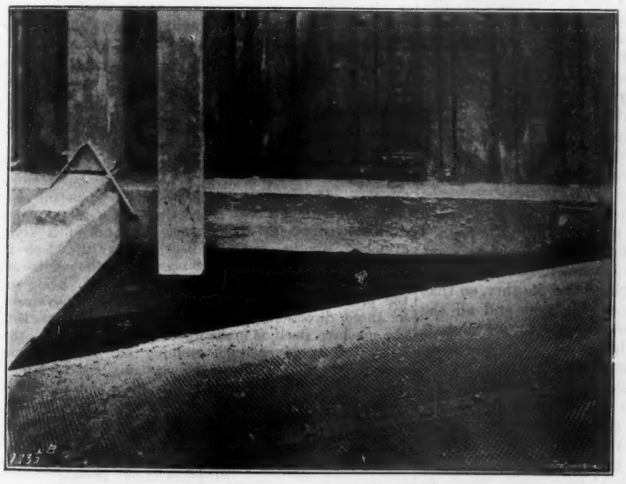



FIG. 5.

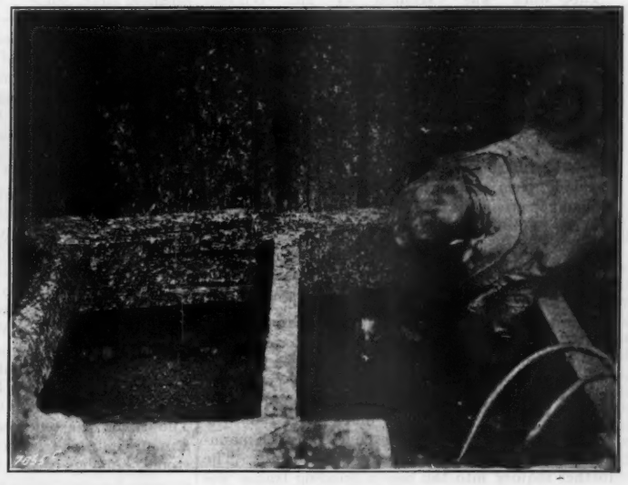


FIG. 6.

For dealing with the water in the interior of the cofferdam, a sump about 6 ft. by 3 ft. on plan was sunk through the concrete floor of the culvert, where shown in Fig. 1. In this sump were installed a 6-in. and a 10-in. centrifugal pumps, the 6-in. one being provided as a standby to enable the foot valve, &c., of the 10-in. pump to be overhauled. The amount of water coming from the springs turned out to be so great that at high water the 10-in. pump could not at all times keep it far enough below the line of cutting. Attempts were made to run both the pumps together, but, owing probably to their suction pipes being so close together, either one or other of them invariably stopped after a few minutes' running.

In order to keep back the water from the outside, during the cutting operations, the line of the proposed cut was covered by a belt of milled clay, 12 in. to 18 in. broad, and about 10 in. to 12 in. thick, which was formed within a timber casing on the outside of the piling, as shown by Fig. 2.

As the culvert floor is 5½ ft. below the level of low water of ordinary spring tides, and the range of tide at ordinary spring is 12¾ ft., it was realised that the pressure of the water might be sufficient to force the clay through the burned cut, and a trial was made with cement-concrete substituted for the clay. This, however, was unsuccessful, as the intermittent load due to the rising and falling of the tide loosened the concrete from the piling. The opening so formed was large enough to produce a considerable flow of water, but too small to allow it to be easily stopped.

With regard to the clay, this movement of the piling produced a puddling effect on the layer of clay next to the piles, and this softened layer was easily pushed through the burned cut by the pressure of the water. It was found necessary to have a diver at work outside the cofferdam, just where the burning was going on, so as to keep the clay jammed hard into the casing, and to make good any place where the water threatened to make a clean passage through. It was important to do the cutting of the piles as soon as possible after the clay was in place, owing to the softening effect of the water on it, but during floods in the river diving work had to be suspended, especially at low water, when the current was greatest. Low water was the most suitable time for burning, owing to the reduced head of water, but, on the other hand, high water was most suitable for diving, owing to the lessened river current. The current during floods was sufficient, especially at the up-river corner of the cofferdam, to remove the clay from the casing.

As soon as a short portion of a pile had been cut through, soft pine wedges were driven into the opening, with the object both of keeping back the

clay and of reducing the leakage of water into the cofferdam.

The greatest difficulty, so far as the actual burning of the piles was concerned, occurred at the interlocking joints, and at the two corner piles (see Fig. 4). The thickness of steel to be burned through at the joints was 1¾ in. and water tended to travel along the interior of the joint, both upwards and downwards, towards the cut. Attempts were made to reduce this flow by the use of oakum and tallow, but they had little success. Owing to the trouble with water, the cut at the joints tended to become so wide as to make it difficult to prevent the clay from being forced through. The projection of the wedges into the interior of the casing made it difficult for the diver to pack the clay in the bottom of the casing thoroughly, or to substitute fresh clay for that which had been softened by prolonged soaking. The corner piles were difficult to reach with the torch, so that a considerable width of cut was necessary here also. The clay was supported in such cases by mixing with it strips of jute sacking, and pieces of tarred oakum.

When the proposal to cut through the steel piling was first considered, it was intended to support each pile as it was cut through by means of a short piece of light-section steel rail, driven down between the bosom of the pile and the edge of the concrete floor of the culvert, and projecting about 6 in. above the cut. This, however, would have interfered with the proper wedging of the cut, and the piles were supported by timber wallings and struts.

Fig. 5 shows a portion of the wedged cut on the up-river side of the culvert, where the cut is on a slope parallel to the top of the culvert wingwalls. Fig. 6 shows the operator at work burning on the river end where the cut is horizontal and about 1 in. above the floor of the culvert.

The work was executed by Mr. William Tawse, public works contractor, Aberdeen, the engineer for the corporation being Mr. H. R. Barr, Assoc.M.Inst.C.E.

## THE DANGERS OF DUST IN METAL GRINDING.

THE terrible mortality among steel-fork grinders has long been recognised. In 1843, Dr. Calvert Holland wrote in his "Vital Statistics of Sheffield," that in 1,000 deaths of persons above 20 years of age, the proportion between 20 and 29 years, in England and Wales, was annually 160, in Sheffield 184, and among the fork grinders 487; between 30 and 39 years the three figures were 136, 164, 410; between 50 and 59 years, the figures were 126, 155 and 0—for there was not a single individual left among the fork grinders. Together with the use of grinding wheels, the dread of grinders' complaint and of pointer's rot (pulmonary decay of needle grinders) spread more and more. By 1909 the Home Office issued regulations concerning the manufacture of cutlery and piercing implements. The further inquiry into the heavy grinding trades was interrupted by the war, during which grinding appliances further multiplied, whilst little regard was paid to the regulations. When the Home Office resumed its inquiry it was resolved to start *de novo* and to include the cleaning of castings. The report just issued on "The Grinding of Metals and Cleaning of Castings with Special Reference to the Effects of Dust Inhalation upon the Workers,"* is a highly-useful monograph on the materials, machinery, practice and hygiene of the metal-grinding industry. The immense amount of labour which Mr. E. L. Macklin and Dr. E. L. Middleton, H.M. Engineering and Medical Inspectors of Factories, have devoted to this Home Office grey book of 100 pages, which is excellently illustrated, has been well spent, and we should like to learn that the suggested amendments to the regulations of 1909 will duly and promptly be considered and enforced.

The additions which science has made to natural abrasives and grinding apparatus have become more and more important. The chief natural abrasives are siliceous sand, used in blasts; sandstones (consisting of free and bound silica) abundant as millstone grit in the lower coal measures; emery, a variable mixture of alumina and iron oxide with some silica; corundum, a purer alumina; tripolite, a form of kieselguhr, hydrated silica; and diamond. Among artificial abrasives the carbides (carborundum) and alumina (bauxite) products rank highest; chilled iron is used like a sand blast, rouge and crocus are iron oxides utilised as polishing agents. The original grindstone, still made in diameters up to 7½ ft. and 1½ ft. thickness to avoid frequent renewal, is being replaced in many fields by the artificial and manufactured stones. There is no sharp distinction between the latter two terms; both refer to chemical products, and the wheel may either be made complete (for tool grinding, emery wheels), by vitrification in a kiln or by bonding the abrasive with sodium silicate (silicate wheels), with shellac, rubber, or oil, or the wheel may be built up of bricks fitting into the recesses of cast-iron skeleton wheels (segmental wheels) so as to protrude both front and back. The glazing or polishing wheels are mostly wooden discs to the circumference of which a rim of hide is glued, this rim being coated with emery.

The great variety is due to the manifold utilisation of abrasives. No engineering shop is without some grinding wheels. They are wanted in the manufacture of cutlery, saws, tools, files; scythes; textile machinery; stoves, grates and fenders; locomotive parts; agricultural implements (*e.g.*, the reaper sections, triangular steel blades); in making tramway points and armour plates, and for rough work, as well as for finishing and decorating.

There are no official statistics available as to the numbers of stones, or grinding wheels, in use; in Sheffield alone some 2,500 are probably used, and all but about a hundred of these are wet; in the textile trade dry stones are much more common. When the regulations of 1909 were drawn up, only the dry, gritty dust from the stones was considered dangerous. It has since become more clearly recognised that danger lurks in wet stones as well. They certainly give less fine dust of abrasives and work, but the exhaust arrangements with upward or downward draught are often poor, the damp "swarf" thrown off contains a good deal of perfectly dry, fine dust, the water may be foul, and the conditions in some gloomy, grimy Sheffield "hulls" are undoubtedly bad. There five men may sit bent over their stones, 4 ft. in diameter, in rooms 8 ft. high, by the side or also behind one another, so that the front man gets most of the light and all the draught on his back. When the stone is all encased in a hood, the hood is liable to be damaged in transport or later, and it is frequently nobody's job in particular to look after ventilation and exhaust; everybody is too busy with his own wheel. The owner of a tenement grinding factory is rarely a manufacturer; he rents the place with power, stones, horsings (seats for the men), &c., and either engages his men, who may change every week, or he sub-lets the accommodation.

The factory tenement system survives because few even of the large firms have all their grinding done upon the premises. These conditions are not general, of course, and Dr. Middleton's average ages of grinders taken from the Sheffield dispensary records, may be questioned as based upon relatively small numbers. But there are certainly far too many grinders of sheep shears, files, razors, and dressers of castings, &c., carried off in their thirties and forties, and ventilation in the shops occupied by these men generally remains too much the engineer's stepchild, while much ingenuity, we also see from the grey book, has been spent upon special grinding devices.

In their recommendations Messrs. Macklin and Middleton draw attention to the often disregarded dangers connected with the truing of the wheels. The racing (turning-up of the revolving wheel), hacking (chipping with a hacking tool) and rodding (intermittent dressing of the revolving wheel by means of a rod or bar) are often performed without any regard to regulations; these operations should not be carried out within tenement factories nor without an ample supply of water. Effective air movement away from the worker and towards the wheel, and a renewal of the air in the room 15 times per working hour should be secured. Adequate drainage, lavatory accommodation and cleaning of rooms and machinery should be obligatory, safety rules should be displayed, and registers of this supervision be kept and be at the disposal of the factory inspectors. Not more than one person should at any time be permitted to use the same glazing or grinding device. Nobody should be allowed to work within 30 ft. of sand-blasting operations in the open air, or to work in a sand blast room unless protected by an efficient helmet, overall and gauntlet.

The recommendations made in the report under notice will not be regarded as too far. Unfortunately both employers and employees are apt to become apathetic, and good grinding is an art to be acquired by experience. But experience would not be incompatible with a change of occupation, were it not for the dread of unemployment.

* Report on the Grinding of Metals and Cleaning of Castings with special reference to the Effect of Dust Inhalation upon the Workers. By E. L. Macklin, O.B.E., H.M. Engineering Inspector of Factories, and E. L. Middleton, M.D., D.P.H., H.M. Medical Inspector of Factories. Published by H.M. Stationery Office; price, 4s. net (4s. 4d. post free).

## GEAR-MEASURING MACHINE.

THE ingenious gear-measuring machine which we illustrate in the views, Figs. 1 to 4, on page 105 and in the drawings Figs. 5 to 28, on that page and pages 106 to 108 was one of the interesting novelties exhibited at the recent Conversazione of the Institution of Civil Engineers, and was designed and constructed in the Metrology Department of the National Physical Laboratory. The design is due to Mr. G. A. Tomlinson, B.Sc., of that department. For the investigation by the department on accurate measurements of gear wheels of various types, a universal machine was required which would admit both of measuring individual specimens, such as spur and helical, plain and spiral bevel and worm wheels, and of recording the errors in the running of combined gears. Our illustrations will show that Mr. Tomlinson's machine fulfils these requirements. Tests of gears within the capacity of the machine are now undertaken at Teddington. The machine measures 47 in. by 40 in. overall, and gear wheels up to 16 in. diameter can be measured.

When a single gear wheel is to be dealt with the machine is used in the form illustrated in Fig. 1, in which, as in the other photographs, certain parts have been removed for the sake of clearness. The gear wheel under examination is shown mounted on an arbor between the centres at the back of the photograph. The spindle of the near centre is so coupled with the large sector disc of Fig. 1 that the two parts move together when measurements are taken by means of a steel ball brought into contact with the teeth under examination. This ball forms the end of a style attached to the pencil indicator, Fig. 2, which is encased in the square box occupying the centre of Fig. 1. The ball has a vertical movement, being on the pivoted style. To provide in all for movement in three directions at right angles to one another, the machine itself is made up of three parts, viz., the base, the lower carriage running on ball races on the base at right angles to the gear axis, and the upper carriage running on ball races across the lower carriage parallel to the gear axis; the movement of each carriage is controlled by a micrometer within 0·0001 in.

The indicator, Figs. 2, 18, 19, 20 and 21, which is fitted by means of a tapered shank into the upper carriage, consists of a light lever suspended by two pairs of crossed flexible steel strips. The long arm is a steel pointer ending in a bevelled sector towards which the right-hand micrometer can be advanced; this movement is observed through a magnifying prism against an illuminated glass window; small changes in the height of the ball of the style are thus measured, mechanically magnified five times, the lever ratio being 5 : 1. With the aid of the other micrometer (see Fig. 18), the lever is lifted in the vertical direction.

The pantograph, Figs. 3, 22, 23 and 24, is designed for special work, and traces the tooth shape on a glass plate coated with soot or with some dye. Like the indicator, the pantograph has a taper shank or plug fitting into a socket in the upper carriage; the two devices fit into separate sockets, however, and only one of them can be in position at the time. The plate is mounted in the square holder shown on the right-hand side of Fig. 3; the mounting, together with a rod support attached, can be detached and the rod inserted in a pillar which, in Fig. 4, is seen in front of the sector disc. The pantograph, distinguished by its very accurate parallelogram suspension of the style, is one of the characteristic features of the machine.

In Fig. 4 the machine is arranged for recording the combined action of two gear wheels which are mounted between the two pairs of centres; neither the indicator nor the pantograph is in position. Figs. 5 to 7 explain the recording mechanism and the methods of taking measurements; they will be found useful in following the somewhat complex details of the drawings Figs. 8

# GEAR-MEASURING MACHINE.

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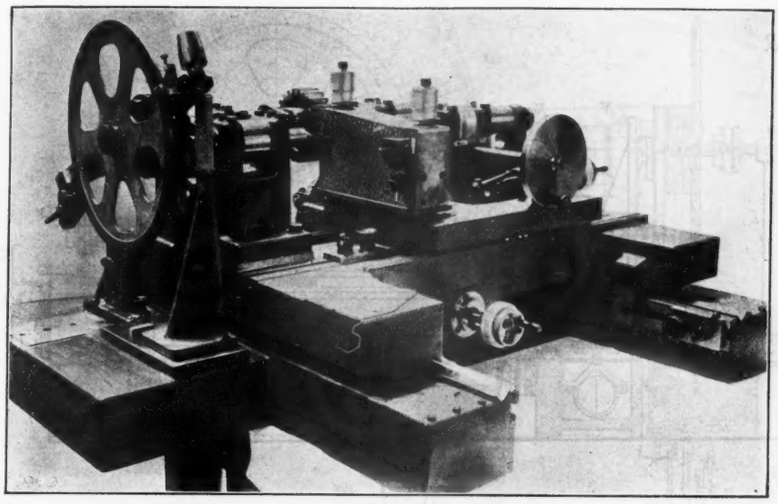


FIG. 1.

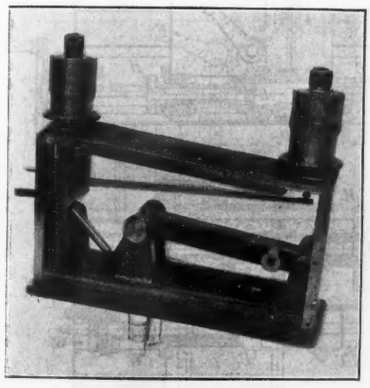


FIG. 2.

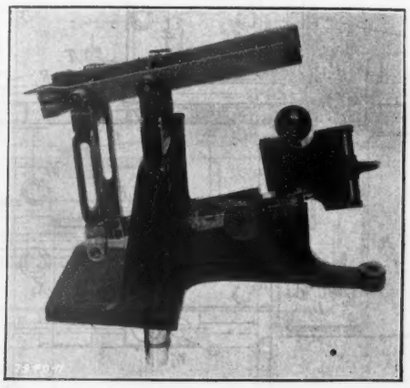


FIG. 3.

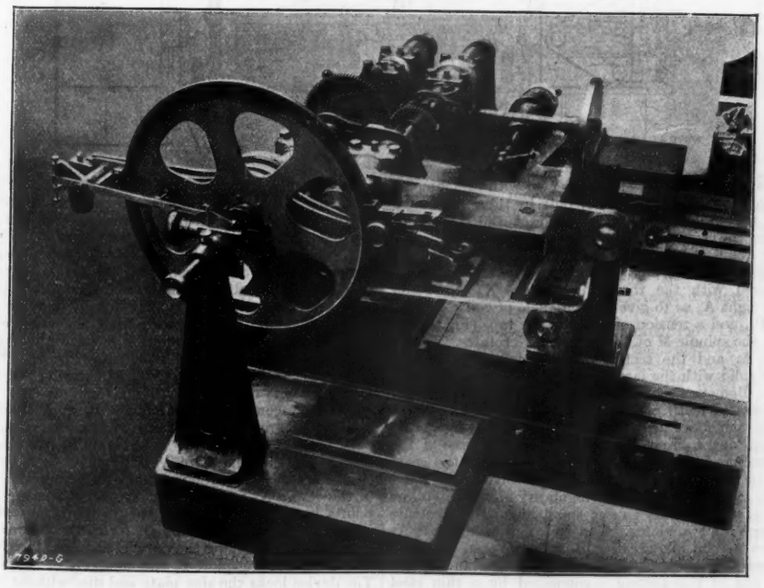


FIG. 4.

Fig. 5.

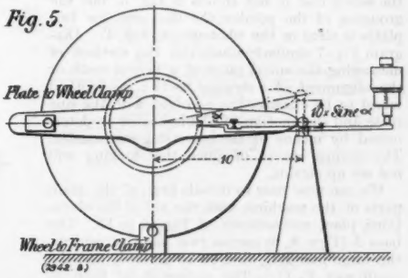



Fig. 6.

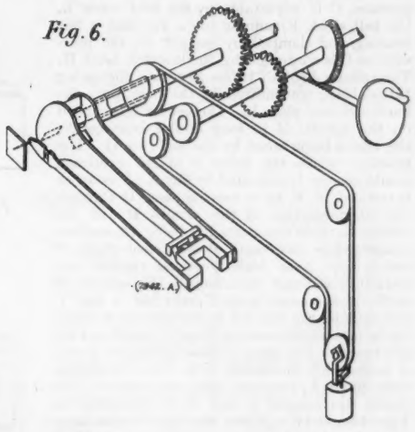
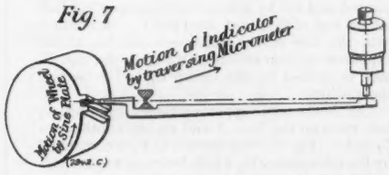


Fig. 7




to 24. Figs. 25 to 28 are examples of records obtained. Before proceeding to the detailed description we will first outline the method of taking measurements.

In determining pitch errors it is desirable to take measurements from flank to flank, as only one set of flanks is driving; the insertion of cylinders might give misleading results since the widths of the spaces may vary. In measuring the pitch the indicator is used. The lower carriage is advanced and the ball of the style brought to bear either upward or downward, preferably on the pitch line; a reading is taken when the micrometer just touches the sector mentioned. The carriage and style are then withdrawn, and the wheel is rotated through an angle equal to the nominal angular pitch; the style is advanced again, and a second reading is taken. The difference between the two readings (divided by five, the lever ratio) gives the pitch error. This process is repeated all round the wheel; some teeth may be omitted if desirable. Accuracy of the angular movement is realised with the aid of a "sine plate" and of the Johansson gauges which are mounted on a pillar, standing in front of the machine (Fig. 1), on a lapped support. A bronze wheel (the sector disc) is rigidly secured to the projecting end of the spindle, coupled to the gear wheel. The boss of the disc forms a bearing on which a long steel bar (the sine plate) can rotate relatively to the disc; the sine plate can be locked to the rim of the disc. At one end the sine plate carries a stud provided with a $\frac{3}{4}$ in. steel ball, at a distance of 10 in. from the centre of the spindle. In the diagram, Fig. 5, is seen the bronze disc, which can be clamped to the frame or base of the machine, and the sine plate with its steel ball at the end resting on the one Johansson block which gives the horizontal zero of the measurement. When another block is added (as dotted in Fig. 5), and the spindle is rotated through the angle $a$, the height of the Johansson gauge will represent 10 sin $a$; to effect this rotation plate and disc are clamped together. Fig. 5 further shows the gear wheel under test and the style of the indicator between two teeth. In the diagram, Fig. 6, of the recording mechanism the gear wheel can be recognised, as well as the spindle passing through a duralumin

plate (later to be mentioned), the sine plate and pointer scratching its record on the smoked glass; details of the steel-spring connections between the two plates will be given below; the sector disc is not shown in Fig. 5, but the grouping of the pointer, the disc and the two plates is clear in the photograph, Fig. 4. Diagram Fig. 7 similarly illustrates the method of measuring the spiral pitch of a helical tooth or the alignment of a straight tooth; the toothed wheel to be examined is revolved with the sine plate and the motion of the indicator is determined by means of the traversing micrometer. The clamps are so designed that locking will not set up strains.

We can now pass to details first of the main parts of the machine, with the aid of the elevations, plan, and sections of Figs. 8 to 12. The base A (Figs. 8, 9) carries two pairs of centres, the large pair B C, first to be noticed, and the small pair $F_2$ $G_2$. The centre B is fixed in position, C is adjustable by the feed screw E, the tail stock F running on a vee and a flat bearing, and clamped by the nut G; the pressure on C is controlled by the knurled head H. The spindle J (of C) is free to rotate, the spring thrust being transmitted by the ball K to the hardened steel plate L. The centre B is carried on the spindle M in long double bearings N, the thrust being taken by the ball race O. The position which the arbor P of the specimen would occupy is indicated in Fig. 9. The arbor is coupled to M by a driving piece Q through the intermediation of the clamps R and the casting S, these two parts RS being themselves connected by two small slotted steel plates T which give both high torsional rigidity and flexibility in other directions. The spindle M ends in a conical nose U carrying a hub V (secured by the nut W) to the flange of which the bronze disc (the sector disc) X (Figs. 9 and 10) is screwed. The outer surface of the hub forms a bearing for the sleeve Z to which the long steel plate $A_1$ (the sine plate) is attached; the clamp $B_1$ clamping X and $A_1$ is illustrated in Figs. 13 and 14. When the disc X has been rotated and set by means of the measuring ball (at the end of the short steel rod $C_1$) in contact with the top of the Johansson blocks, as we explained in connection with Fig. 5, the disc X may be locked by the clamp $E_1$ to the base of the machine.

The lower and upper carriages running on ball races on the base A and on one another are $F_1$ and $S_1$ (Fig. 8). The motion of $F_1$ is controlled by the micrometer $G_1$ which bears on a spherical-ended stop $H_1$ carried by the rod $J_1$ clamped to the base at $K_1$ (Fig. 11); a cord and weight keep the micrometer up to the stop. By means of the clamps $M_1$ (bottom of Fig. 9) the carriage can be locked on either side; each of these clamps consists of a plate $N_1$ running in a tee slot in which it is fixed by means of the bolt $O_1$. The carriage has a flexible steel tongue $P_1$ (Fig. 8) which passes between $N_1$ and the steel strip $Q_1$ to be gripped by the screw $R_1$ (Fig. 9); there is hence no strain on the ball races.

The upper carriage $S_1$ is controlled by the micrometer $T_1$ (Fig. 9) bearing against the stop $U_1$ under the influence of the weight and cord $V_1$; this stop is adjustable and bolted to the lower carriage; the clamps $W_1$ correspond to the clamps $M_1$ already mentioned. Near the centre of the upper carriage are the tapered sockets $X_1$ and $Y_1$ for either the indicator or the pantograph. In order to be able to draw the lower carriage back (in disengaging the indicator from the teeth of the gear) the thin-oil plunger dashpot $Z_1$ (Fig. 12) has been provided in channels of the base casting on either side. The brass cylinder $A_2$ of the dashpot is closed at the one end $B_2$ except for the needle valve $C_2$; this cylinder is carried by the lower carriage whilst the plunger $D_2$ is attached by a universal joint to the base.

The second pair of centres $F_2$ and $G_2$ (Fig. 9) for the smaller gear, is set at the required distance with the aid of the micrometer $G_1$, $F_2$ being carried by the lower carriage and $G_2$ by the upper; for these combined gear measurements the two carriages are clamped. The small gear to be tested is coupled by the driver $H_2$ to the spindle $J_2$ which can be slowly rotated by the hand wheel $L_2$ (near bottom of Fig. 9) through the reduction worm-gear $K_2$. The large gear (between centres B and C) on being driven, winds up a weighted cord $N_2$ on the pulley $O_2$ (top of Fig. 9) so as to maintain a constant pressure between the teeth engaged. At the headstock end of the arbor carrying the small gear, a flanged disc $R_2$ is fitted to the spindle $Q_2$. On the axis of the larger gear there is a second flanged disc $S_2$ carried by a light-alloy casting $T_2$ and held on by the nut $U_2$. This casting carries also the duralumin plate $V_2$ above mentioned (*see* Fig. 9), which is similar in shape to the sine plate $A_1$. The casting $T_2$ with attachments is connected to the sleeve Z only by three laminated steel strips $W_2$ radially arranged at 120 deg., thus leaving the casting one degree of freedom, in a rotational sense about the spindle axis. The two discs $R_2$ and $S_2$ are connected by a thin endless steel tape so arranged with the three idle pulleys $X_2$ $Y_2$ $Z_2$ and the weight $A_2$ as to give a large angle of coil round $R_2$ and $P_2$, and a tension of 1 lb. on the tape (Fig. 10).

As the spindle M of the large centre rotates, the sine plate $A_1$ and the sector disc X (clamped together) move solid with the large gear. The discs $S_2$ and $R_2$ have diameters corresponding to the ratio of the numbers of teeth of the gears; $S_2$ therefore rotates at the same average speed as M, but it receives its motion direct from the small gear by virtue of the constraint of the coupling tape. Hence, as the gears turn in mesh, the plates $A_1$ and $V_2$ revolve at the speed of the large gear, but any irregularity in the pitch line motion of the gears causes small angular movements between the two plates. The end of the sine plate $A_1$ carries a light alloy casting $B_2$ supported on a pair of crossed steel strips $C_2$ (Figs. 9, 10 and diagram Fig. 6). One arm of this casting is connected by a thin steel member $D_2$ to the plate $V_2$; the other side of the casting carries the light pointer $E_2$ held by the screw $F_2$ and the adjusting screws $G_2$; the pointer ends in the steel point $H_2$, which traces a record on the smoked glass plate $J_2$. The general shape of the record will be circular or spiral, and the dimension across can be varied by the screws $G_2$ which control the offset of the point $H_2$. The record can subsequently be examined by optical projection (independently of the machine) to show the combined effect of all the errors of both gears.

In assembling the disc $S_2$, the hub V, together with its attachments, is withdrawn from the taper shank of the spindle M; this operation is facilitated by the nut W and the extraction flange $K_3$ (Fig. 9). When not in use the bracket $L_3$ (Fig. 8) carrying the glass record plate is removed.

The arrangements of the clamps $B_1$ and $E_1$ will be understood from the diagrams Figs. 13 and 14, and Figs. 15 to 17 on page 107. The clamp $B_1$ coupling the disc X and the sine plate $A_1$ is double; the screw $M_3$ (Fig. 13) serves as a rough clamp for fixing the body of the clamp $N_3$ to the sector disc X; there are three points bearing on two faces $O_3$ (on the disc) and one ball $P_3$. The eccentric cam $Q_3$ forms the fine clamp; it operates by gripping the parallel floating plate $R_3$ between the floating plate $S_3$ and the body of the clamp. The device locks the sine plate and disc without strain and without the possibility of any angular movement on tightening the clamp; when the screw $M_3$ is turned, the body to be clamped is handled, but on

# GEAR-MEASURING MACHINE.

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*Fig. 8.*

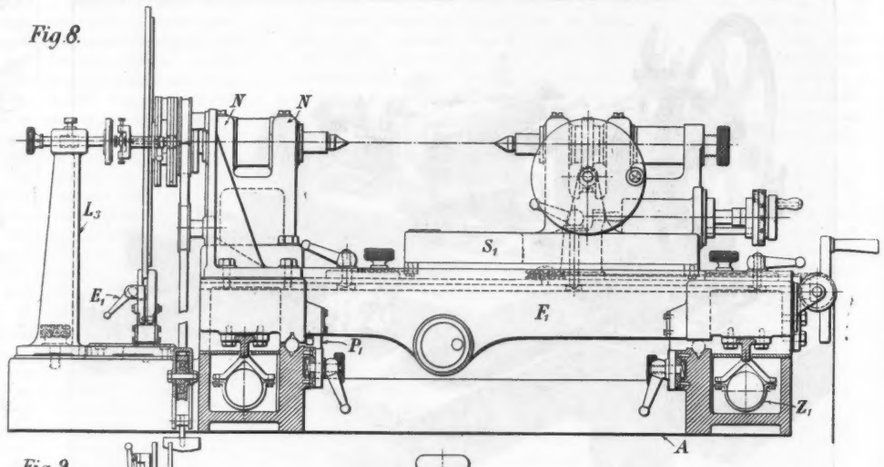
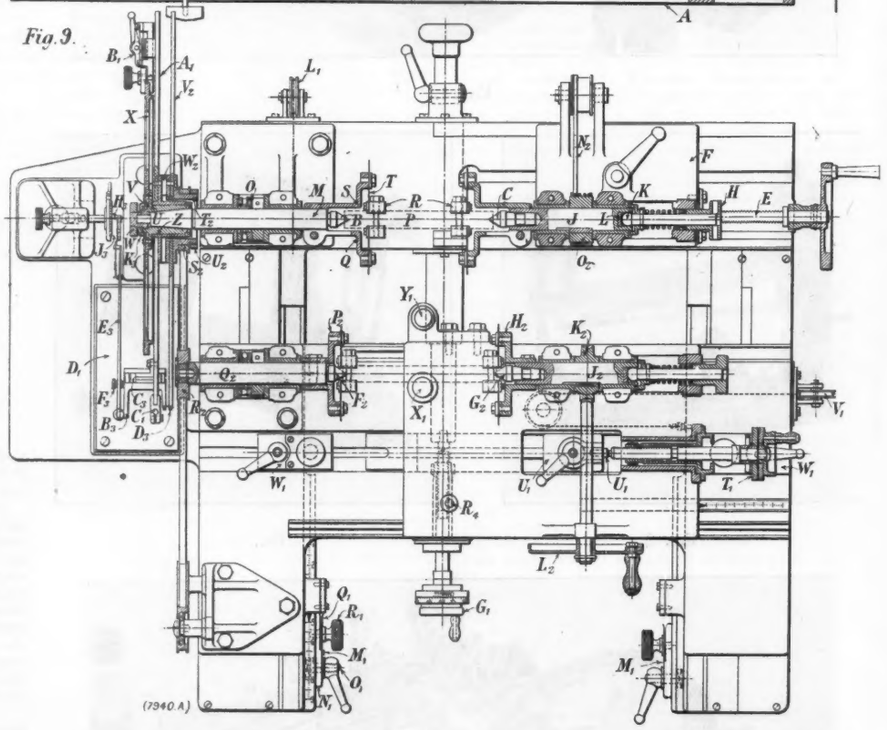



*Fig. 9.*



# GEAR-MEASURING MACHINE.

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Fig. 10.

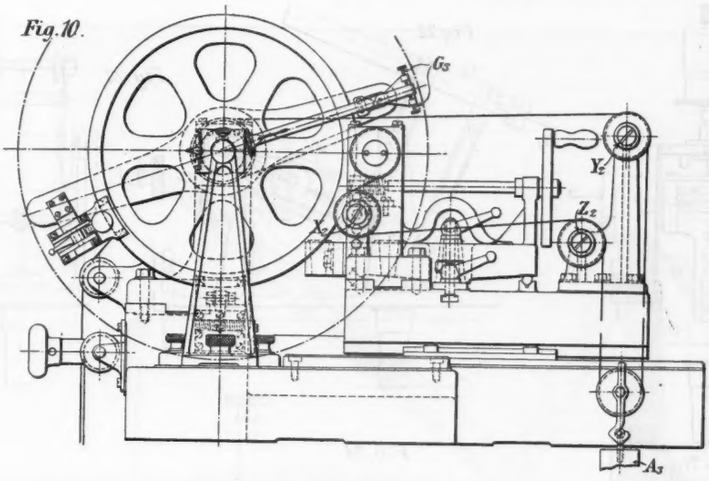



Fig. 11.

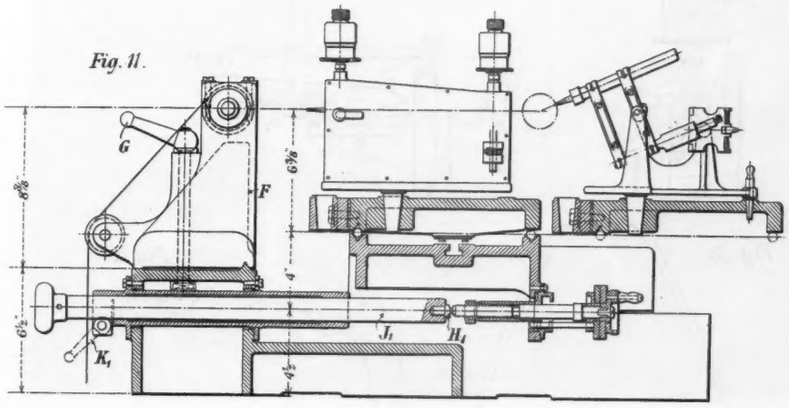



Fig. 12.

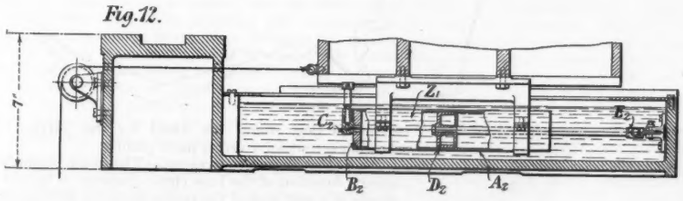



Fig. 13.

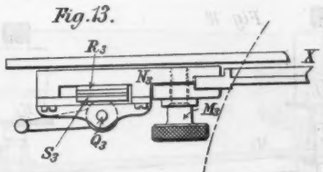



Fig. 14.

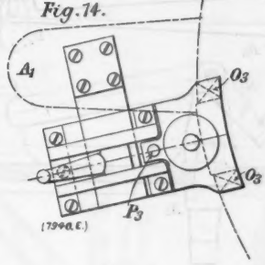



Fig. 15.

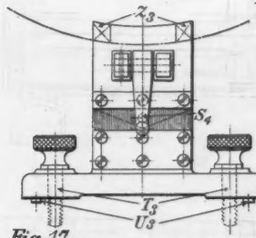



Fig. 16.

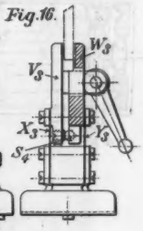
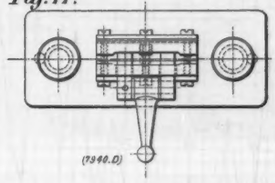



Fig. 17.




finally using the cam $Q_3$, force is only applied to a part which is already held fixed. The clamp $E_3$ (Fig. 8 and Figs. 15 to 17) clamps the sector disc X to the base of the machine by the aid of the screws $T_3$ and the dowels $U_3$. The two plates $V_3$ and $W_3$ are supported by broad flexible steel strips $X_3$, $Y_3$, and the clamp is again a three-point bearing on two facets $Z_3$ and a ball $S_4$. The device ensures a high degree of rigidity in the plane of the disc motion together with slight flexibility in other directions to avoid strain.

*The Indicator.*—The indicator (see Fig. 2 and Figs. 18 to 21) is placed, as mentioned, with its tapered stem $A_5$ in a socket of the upper carriage and consists essentially of a lever $B_5$, arm ratio 5 : 1, the short arm of which is the spherical-ended style $C_5$. The end of the long arm carries a curved knife edge $D_5$ for reading small vertical changes in the position of the style ball by the micrometer $E_5$. The lever is suspended on light crossed steel strips $F_5$. The small throw-over lever $G_5$ (Fig. 20) makes the ball either bear in an upward or downward direction. The edge of the sector knife is observed through an adjustable triangular glass prism $H_5$ against the illuminated ground glass window $J_5$. The plate $K_5$ (Fig. 19) from which the lever is suspended has a vertical travel of 1 in. on steel ball races; this motion is measured by the micrometer $L_5$, which has a spherical end bearing on a hardened lapped face $M_5$. The weighted crank lever $N_5$ and the pointed strut pin $O_5$ hold the plate $K_5$ against the ball race, and also against the micrometer. Large movements of the ball in a vertical direction can be read, if necessary, by the micrometer $L_5$ together with the micrometer $E_5$; most commonly only small variations in the height of the ball come into question and the sensitivity of these measurements is 0·00002 in. The whole indicator swivels on its tapered stem to admit of bevel gear measurements.

*The Pantograph.*—The pantograph (Figs. 3, and Figs. 22 to 24) swivels like the indicator about the axis of its tapered stem, inserted into one of the two sockets on the upper carriage. Its plane of action is located normal to the axis of the gear wheel under examination by the pin $A_4$ (Fig. 22). The tracing point $B_4$ is a spherical-ended style clamped in vees on the upper link $C_4$ of a parallelogram. The marking point $D_4$ is a fine tempered steel point bearing on a smoked glass plate $E_4$ with a pressure of about 10 milligrammes. The record traced is a line about 0·0002 in. wide reproduced with an error not exceeding 0·0001 in. To secure this accuracy the link parallelogram has been made with the utmost care by the Metrology Department. The plate $F_4$ carrying the scribing point is adjustable in position relatively to the lower link $G_4$; the error in the position of the scribing point can be determined experimentally and be eliminated by this adjustment. The fixed axis is formed by the ground steel point centres $H_4$ (Fig. 24) bearing on the short rods (of mild steel) $J_4$ held in the frame casting. The four corner pivots are formed of 60 deg. cone points (of hardened steel) in centres on the spindle $L_4$, the cones and centres being highly lapped and polished. The short flexible steel strip $L_6$ in the lower link helps to accommodate any slight strain. The marking point $D_4$ is held by a very light steel plate $M_4$ attached to the plate $F_4$ by two short steel strips $N_4$, which form a vertical pivot and supply the necessary very small pressure. In withdrawing the point from the glass plate use is made of a light spring wire $O_4$ which is deflected by the screw $P_4$.

The pantograph is balanced about its fixed axis so as to be in equilibrium for all shapes and positions. The actual record of a tooth profile obtained—magnified 50 times by projection—is not the actual shape of the tooth, but represents the path of the centre of the ball and is therefore an envelope to the plane section of the tooth. It is an easy matter either to reproduce the tooth shape from the projected record, or to draw the line diagram used for comparison as the envelope and to compare the record with it direct. With helical or bevel teeth the geometry of the ball-contact is more complex. But Mr. Tomlinson finds on investigation that the record is still an envelope of the plane section of the tooth to a very close degree of approximation, so that no complications arise in applying the pantograph to such teeth. The pantograph is set accurately with its plane of action perpendicular to the gear axis by the locating pin of the hole $Q_4$ (Fig. 24) fitting into the seating $R_4$ of diagram Fig. 9. For use on bevel gears the plane of action is set normal to the pitch cone by coupling $Q_4$ and $R_4$ by a suitable link.

*Use and Performance of the Machine. Straight Spur Gears. Pitch Errors.*—We now pass to the performance of the machine. We have already indicated how pitch measurements are made on straight spur gears. The sine plate is set to zero position; the indicator is

# GEAR-MEASURING MACHINE.

DESIGNED AND CONSTRUCTED AT THE NATIONAL PHYSICAL LABORATORY.

Fig. 18.

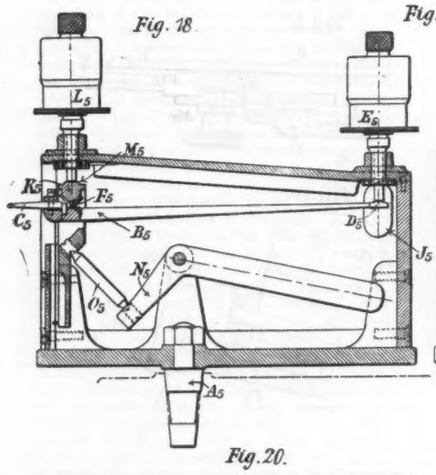



Fig. 19.

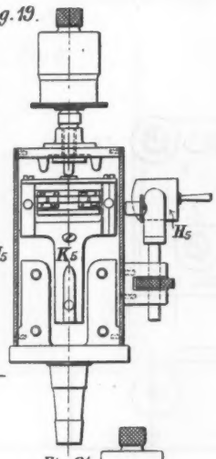



Fig. 22.

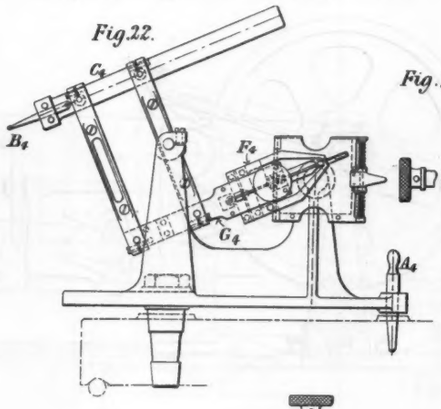



Fig. 23.

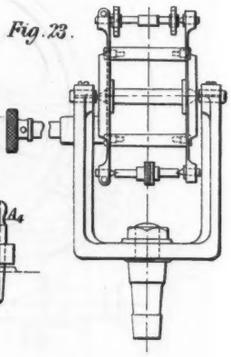


Fig. 20.

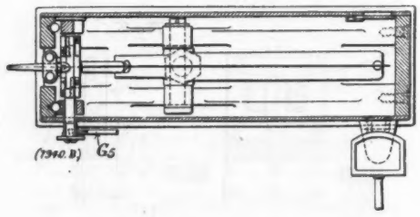



Fig. 21.

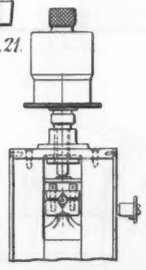


Fig. 24.

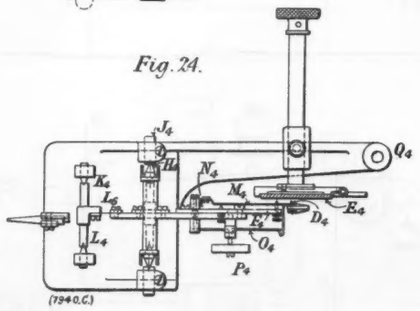



Fig. 25.

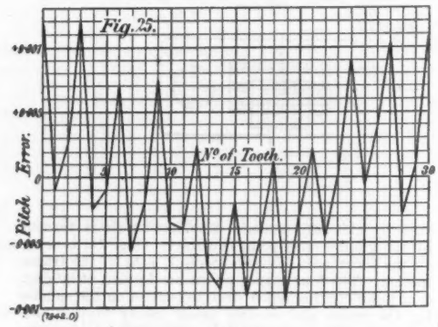



Fig. 26.

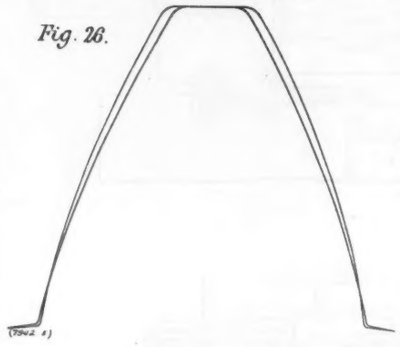
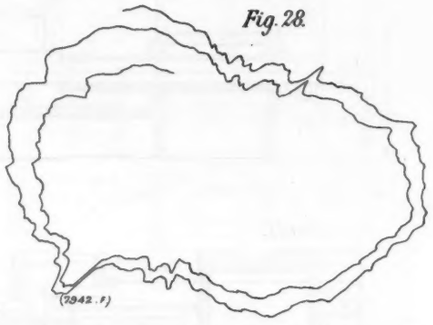



Fig. 28.

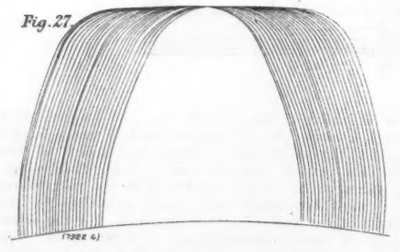



advanced so that the style ball bears on the tooth flank; the gear is rotated successively through the nominal angular pitch by the sine plate, and each time a reading is taken on the micrometer $E_5$ (Fig. 18). The differences give five times the variations in pitch in linear measure, at the radius represented by the distance between the ball centre and the gear axis, which is made closely equal to the pitch radius. An example of the pitch errors thus determined of a 30-tooth spur wheel is given on Fig. 25; there is a pronounced periodic indexing error recurring every three teeth.

*Tooth Profile. Parallel and Radial Alignment. Group Records of Teeth. Concentricity.*—In order to check the alignment of the teeth parallel to the gear axis the indicator is set in contact with the tooth flank at one end and a reading is taken; the indicator is then traversed along the tooth by the feed micrometer $T_1$ (Fig. 9) and a series of $E_5$ readings are taken which give the errors in alignment directly. Measurements of tooth form and thickness might be effected by a point to point method, by observing pairs of co-ordinates of the indicator ball. In order to obviate this laborious method, the pantograph was devised, which traces a profile of the tooth shape. When the profile of a tooth has been recorded, with the aid of the pantograph, on both flanks, the gear is reversed on its centres, and the same tooth is once more recorded in closely the same position as before. The two sets of flanks should coincide or appear as almost parallel curves close to one another. If they diverge, the angle of inclination measured on projection gives double the error in radial alignment of the tooth. An example of this deviation from radial symmetry is reproduced in Fig. 26.

With the help of the sine plate and pantograph records can be obtained showing the whole of the teeth spaced with an arbitary and very small artificial pitch of one or two thousandths of an inch. Such a group recorded (Fig. 27) represents nominally a series of similar curves spaced so close together that very small variations in pitch or profile are seen at once on projecting the record. In order to obtain this group record, a start is made with some particular tooth, the complete profile of which is traced. The sector disc (the X of the diagrams) is then rotated by means of the sine plate through the nominal angular pitch plus or minus a small angle subtending the required amount at the pitch line of the gear; for this purpose a suitable modification in the value of the pile of Johansson gauges is required. The process is repeated on each tooth in turn. The group record will also reveal any eccentricity errors and can thus serve for testing the concentricity of the teeth and axis. A similar record may be taken of only six teeth at intervals of about 60 deg. round the wheel for the purpose of showing eccentricity errors more plainly.

Fig. 27.



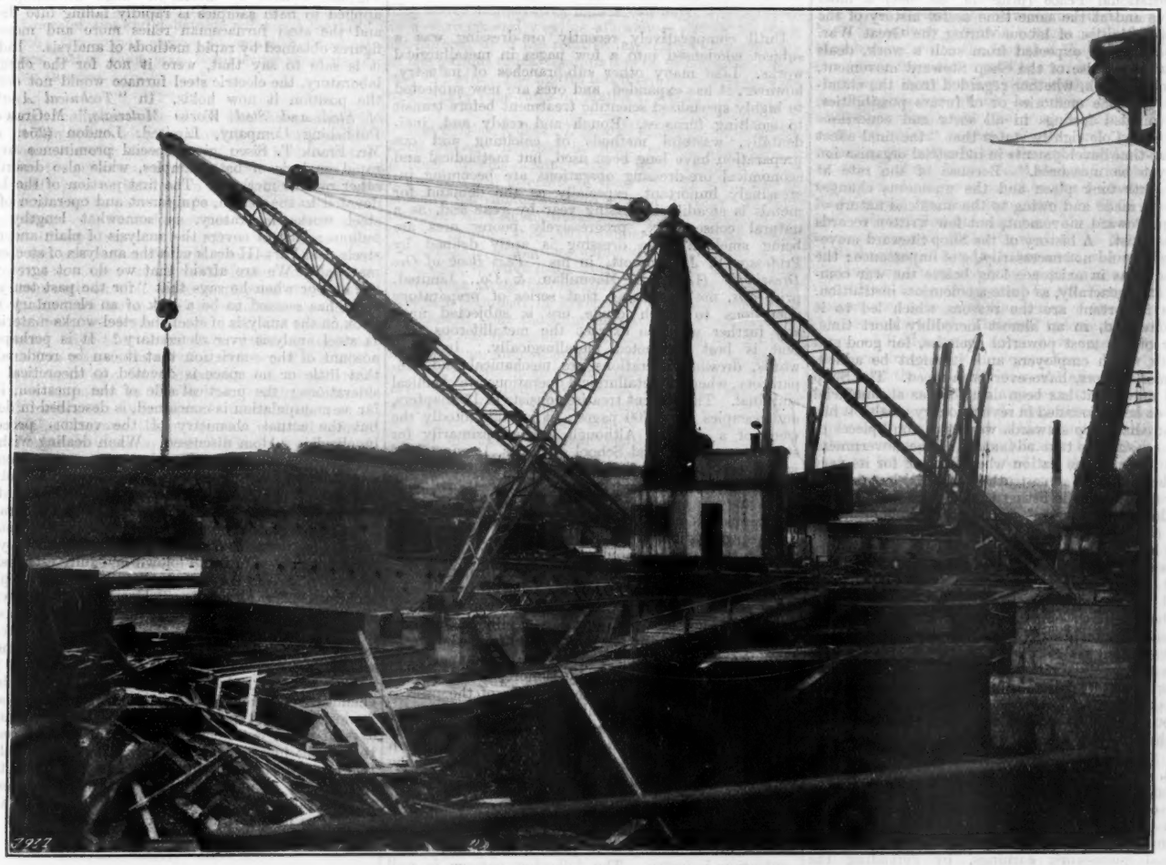

*Pitch Diameter Measurement.*—The pitch diameter being a function of the base circle diameter of both the wheels of a pair and of the centre distance between the wheels, is not an explicit dimension. The base-circle diameter can be, however, accurately determined with the aid of the pantograph. A tooth record is taken and the gear wheel is replaced by a plain cylinder of known diameter; a portion of the circumference is traced on the same record, in such a way that the arc of the circle intersects the flanks of the tooth previously traced. The base-circle diameter can be then graphically derived in terms of the diameter of the cylinder by a simple construction on the board of the projector, the construction being based on the properties of the involute.

*Helical Gears.*—With helical gears most of the elements are determined in the same way and with the same ease as in the case of straight spur wheels, and the direct measurements of radial alignment, group records, and base-wide diameter could probably not be effected for helical gears except with the aid of the pantograph. For the determination of helical pitch and pitch angle the indicator is used. It is set in contact with the tooth flank at one end, and is moved along in a series of equal steps by traversing the upper carriage, while at the same time the gear wheel is rotated in stages by the sine plate, through the appropriate angle determined by the helical pitch. The readings of the indicator then give the deviations of the specimen from the nominal true helix.

*Bevel Gear.*—The pitch measurement of bevel gear is carried out as above explained, except that the

# 50-TON STEAM DERRICK CRANE.

CONSTRUCTED BY MESSRS. ALEXANDER JACK AND COMPANY, LIMITED, ENGINEERS, MOTHERWELL.



indicator is swivelled round in its tapered socket so that the plane becomes normal to the pitch cone. Tooth profile and pitch diameter are conveniently examined together in bevel gears because the section of the tooth is variable. By examining the same profile section, from which the pitch diameter is determined, the position of the section is located on the pitch cone. The procedure is as described, but the bevel tooth must be in the horizontal plane through the gear axis. The determination of group records and eccentricity do not call for special remarks. When the tooth taper is to be examined, the tooth is adjusted to lie symmetrically in the horizontal plane through the gear axis. A series of sections is then traced by the pantograph at equal distances apart from end to end of the tooth. To do this the pantograph is traversed in an inclined direction by feeding the carriages with component motions proportional to the sine and the cosine of the pitch-cone angle. The record will show any errors in uniformity of taper and indicate also whether the centre line of the tooth correctly intersects the axis of the pitch cone.

*Spiral Bevel Gears.*—The method of procedure is broadly the same as for straight bevel gears. Tooth taper and spiral curve are determined as in the case of the measurement of the tooth taper of bevel gears, with the additional condition that the gear is rotated by the sine plate, each time the pantograph is moved along, through the nominal angle corresponding to the displacement of the section.

*Worm Gears.*—Measurements of a worm wheel taken in the central plane of the wheel are obtained as in the case of helical wheels.

*Record of Irregularity of Motion.*—How records of the combined action of gears are obtained has already been explained. When the pantograph record is magnified 50 times by projection, the final scale will be nearly 1 in. per minute of angle. The record reproduced in our last diagram, Fig. 28, illustrates, of course, a bad case; the wheels had 35 and 70 teeth respectively. But the record marks the composite effects of the errors in all the elements of both gears and its function is to indicate rapidly, and yet accurately, the class of workmanship; for purposes of investigation this record should be supplemented by direct measurements of the separate elements. The gradient of the record gives the relative acceleration between the members of the gear to a scale depending upon the speed of running.

We wish to express our indebtedness to the Director of the National Physical Laboratory, to Mr. J. E. Sears, Jun., superintendent of the Metrology Department, and particularly to Mr. Tomlinson for the detailed information placed at our disposal enabling us to describe the latest of the many interesting measuring machines which have originated in the Metrology Department.

## 50-TON STEAM DERRICK CRANE.

WHEN a jib crane is required to cover a given area, the lightest and cheapest type of crane that can be installed is that known as a Scotch derrick. As compared with a pillar crane or a cantilever crane of the "giant" type, it has the disadvantage of not being able to swing all round, the slewing movement being limited to rather less than 270 deg. This limitation is in many cases no serious disadvantage, and the derrick crane is then the most economical form. The feature of economy applies not only to the machine itself but to the foundations. The triangulated structure of the derrick crane calls for support at three points, on all of which the loads are vertical. The main base under the mast takes compression only; while the foundations under the outer ends of the stays are little more than ballast weights to prevent the crane over-turning, although subject to compression in certain positions of the jib.

The illustration above shows a large crane of the derrick type recently installed for ship-breaking purposes. It is erected on three concrete piers, two of which are in the water. A sloping foreshore of soft mud made the work of erection extremely difficult, and the heavier parts had to be floated to the site on a barge. The crane has a jib 110 ft. long between centres, and is designed to lift a working load of 50 tons at a radius of 75 ft., 40 tons at 90 ft. radius, or 35 tons at 100 ft. radius. It was tested in all its motions with a load of 60 tons at 75 ft. radius. The engines are supplied with steam at 100 lb. pressure from a boiler of the vertical type, 6 ft. diameter by 12 ft. high.

The derricking and hoisting motions are intergeared as is customary with this type of crane. This intergearing has the effect of balancing the descending jib by the ascending load and giving approximately a level luffing motion. As a precaution against errors on the part of the driver the levers operating the hoisting and derricking clutches are interlocked as far as possible. There are also red "danger" discs which appear when the cycle of lever movements is incomplete. The movement of another lever completing the combination withdraws the danger disc, and the engines can then be started up. The bottom pivot about which the crane turns is subject to a vertical load of over 200 tons, due to the weight of the parts, and the thrust of the jib and diagonal stays, under full load conditions. The area of the pivot was therefore made large so that the lubricant should not be squeezed out, and a ball and socket ensures an equal distribution of the pressure, irrespective of errors of alignment, as the crane rotates. The lubricant is introduced under pressure so that the crane floats on a film of grease and slews very easily. The crane was designed and made by Alexander Jack and Co., Limited, of Motherwell.

COPPER PIPE BENDS.—A demonstration took place at the works of Messrs. Mechans, Limited, Scotstoun, Glasgow, recently, of a method of manufacturing copper pipe bends which is being put forward by Messrs. D. Harvie and Co., Clydebank Works, Dalmarnock Bridge, Rutherglen, Glasgow. This method consists in using a hydraulic press with dies to shape out the two halves of the bend, which after they are shaped must be fitted, brazed and worked. It would appear that the cost of the dies and of the pressing might be prohibitive for any other than purely repetition work, but Messrs. Harvie are now laying down plant for the manufacture of all kinds of copper bends by their new process, and they propose to standardise the radii as much as possible, so as to supply shipbuilders and engineers with the bends.

## NOTES ON NEW BOOKS.

Under the somewhat misleading title of "*Workshop Organisation*," by G. D. H. Cole, the Clarendon Press, Oxford, has published for the Carnegie Endowment for International Peace (price 7*s.* 6*d.* net) a most instructive and at the same time useful history of the workshop activities of labour during the Great War. This, as might be expected from such a work, deals largely with the rise of the Shop Steward movement, a movement which, whether regarded from the standpoint of war-time memories or of future possibilities, arouses mingled feelings in all sorts and conditions of men. Mr. Cole rightly states that "the final effect of the war-time developments in industrial organisation cannot yet be measured." Because of the rate at which events took place and the numerous changes which were made and owing to the unofficial nature of the Shop Steward movement, but few written records of events exist. A history of the Shop Steward movement itself would not necessarily be of importance; the movement was in existence long before the war commenced and, generally, as quite a colourless institution. What is important are the reasons which led to it being converted, in an almost incredibly short time, into one of the most powerful agencies, for good and evil, with which employers and, it might be added, trade union leaders, have ever been faced. The Shop Steward movement has been described as an unofficial one and as being founded in revolutionary ideals; it has been said that shop stewards were the mouthpieces of men who desired to take advantage of the Government and the needs of the nation when fighting for its very life. There may be some truth in all this, but there is another side, and it is fitting that all the facts should be set down in cold print so that the whole situation may be reviewed and the real lessons of that turbulent period learnt. Time, however, is a wonderfully effective sifter, and already there are signs that the chaff is being dispersed. One of the first fruits of the Shop Steward movement was the "Whitley" Councils, but "the Whitley Councils have, in nearly all cases, quite failed to realise the large promises with which they were inaugurated. . . . Judged by its pretensions the whole Whitley scheme has broken down; and nowhere is its failure more obvious and complete than in the sphere of workshop organisation." Mr. Cole does not admit that the fault lies with the workmen, nor perhaps is this necessary; the significance of the fact is that "the large promises" have not been realised. In connection with the question of "collective contract" there is an interesting reference to a scheme of collective bonus which "was discontinued because of the resistance to it of the older men, who complained that it took away their chance of high individual piece-work earnings, by spreading the earnings on the whole output more evenly over the whole of the workers in the shop." Probably "dilution" was the chief cause of the shop stewards rise to power, and in this respect a real need, from the workers' point of view, existed. Changes were being made which threatened "rights" of long standing and to watch these interests people were required who were on the spot. The Shop Steward seized his opportunity, and owing to the shortage of men and sometimes the bewilderment of management, seized more than the circumstances called for. A number of appendices are given which have more than ordinary value; among these are to be found memorandums on "shop committees," collective contract, Whitley schemes in the Royal Dockyards, a firm's "rules for shop stewards," an extract from a report dealing with the Clyde Workers' Committee, &c.

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Radiotelegraphy and radiotelephony, in evidence everywhere, have become of great importance to the bookseller. The numbers of papers and books on the subject are amazing. In the "*Drahtlose Telegraphie und Telephonie*" of Dr. P. Lertes, of the University of Frankfurt (Dresden and Leipzig: Theodor Steinkopf; price 3*s.*), the items in the literature lists, added to the sections of the volume of 200 pages, run into many hundreds, though no publication of a date before 1914 is noticed. Dr. Lertes disclaims the intention of writing a handbook; we should accept his volume as a useful handbook, intelligible to the untrained and enabling the specialist to follow up the developments of late years. The book is up to date to an unusual extent; though this second edition has followed the first within a year, the volume can certainly not be called a reprint with complementary sections; the whole is re-written so far as was necessary. We regret one feature, the terminology. We are astonished that Dr. Lertes should speak of "drahtlos" (wireless) and of "Röhrensender" (tube transmitters). The term "radio" enjoys official sanction, while "Röhre" is not much less a word for nearly everything than "tube" is over here now. But we do not consider such American terms as pliotron (a kinotron with a grid), dynatron (a thermoionic valve with a perforated anode, equivalent to a negative resistance), negatron (a valve with two anodes and one grid), as any more fortunate, because singular. The nomenclature of a rapidly developing science and industry is undoubtedly a difficult matter. The influential scientific and technical institutions might do more to check arbitrary word coining.

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Until comparatively recently ore-dressing was a subject condensed into a few pages in metallurgical works. Like many other sub-branches of industry, however, it has expanded, and ores are now subjected to highly specialised scientific treatment before transit to smelting furnaces. Rough and ready and, incidentally, wasteful methods of calcining and ore preparation have long been used, but methodical and economical ore-dressing operations are becoming increasingly important, especially as the demand for metals is steadily increasing year by year and, as a natural consequence, progressively poorer ores are being smelted. Ore dressing is aptly defined by Professor S. J. Truscott, in his "*Text Book of Ore Dressing*" (London: Macmillan & Co., Limited, price 40*s.* net), as being that series of preparatory operations to which crude ore is subjected until any further work to extract the metalliferous content is best conducted metallurgically. In other words, dressing operations are mechanical and preparatory, whereas metallurgical operations are chemical and final. The present treatise consists of 15 chapters, and occupies some 700 pages; it is undoubtedly the work of a master. Although written primarily for students at the Royal School of Mines, London, it is well worthy of a place in the libraries of all mining and metallurgical concerns. Preliminary operations, such as sorting and crushing, and the older more commonly-used processes, such as roasting, calcining, water sizing and concentration, are all dealt with in detail. The author takes, throughout, the practical commercial view and confines himself to modern methods of procedure; he does not weary the reader with descriptions of obsolete processes. Flotation concentration, now established as a prime process of mineral dressing, is given an important place by the author, who states that the first flotation process to be commercially applied was that developed by Elmore, of London, in 1898. Broadly speaking, the principle of the process depends on the fact that oil has a greater affinity for mineral than for gangue. The whole question is discussed in all its aspects, and, finally, figures are given showing how the advent of flotation has increased the recovery of previously lost metal in a most remarkable way. Although at present chiefly used in the non-ferrous metal industry, flotation is shown to possess great possibilities and is, in all probability, destined to have a still more important place in the mineral concentration industry. The following passage is well worth quoting: "At the expense of water-concentration, flotation has progressed not only because of the improved recovery which it brings, but also because of the low cost and the high capacity of its machines, these factors so reflecting upon the working cost that, in spite of the necessity to grind finer and the greater consumption of power, the operating cost of flotation is much the same as that of water-concentration. Where flotation is added to treat fine material formerly run to waste, the total cost of treatment will naturally be somewhat increased, but that increased cost is abundantly made good by the improved recovery. This improvement in recovery varies with the extent to which flotation is applied, and with the particular ore; in general terms, where formerly water-concentration yielded a 65 per cent. to 70 per cent. recovery, the adoption of flotation might well raise the recovery from 80 per cent. to 85 per cent." Recent developments in magnetic, electrostatic, pneumatic, and centrifugal separations and the improved modern processes now in use are admirably well set out. The author concludes by giving sound practical advice on the control of operations generally, the commercial application of various dressing systems and the setting out of complete industrial plants.

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The work of ships' designers and draughtsmen embodies such an amount of detail calculation that a reference book enabling them to arrive rapidly at required figures is always a great help. "*Jordan's Tabulated Weights of Iron and Steel*" is well known to them. The seventh edition of this book was issued in June, 1918. The eighth edition is now available and contains a series of new tables based upon standard ship sections drawn up by the British Engineering Standards Association, and published by the association in July, 1920. Further, the references to the Rules of Lloyd's Register have been revised in the light of the society's new rules published in July, 1922. A large number of the tables given will also be found of great service by engineers in charge of the design of iron and steel structures in general. The book is edited by Lloyd's Register of Shipping, and is issued at the price of 15*s.* net by Messrs. E. and F. N. Spon, Limited, 57, Haymarket, S.W. 1.

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That a chemical laboratory is an indispensable adjunct to a steel works plant is now a recognised fact. Furnace control by means of rough workshop tests applied to bath samples is rapidly falling into disuse, and the steel furnaceman relies more and more on figures obtained by rapid methods of analysis. Indeed, it is safe to say that, were it not for the chemical laboratory, the electric steel furnace would not occupy the position it now holds. In "*Technical Analysis of Steel and Steel Works Materials*," McGraw-Hill Publishing Company, Limited, London (25*s.* net), Mr. Frank T. Sisco gives special prominence to the rapid analysis of bath samples, while also describing other routine methods. The first portion of the book, devoted to the design, equipment and operation of the steel works laboratory, is somewhat lengthy and tedious; Part II covers the analysis of plain and alloy steels, and Part III deals with the analysis of steel-work materials. We are afraid that we do not agree with the author when he says that "for the past ten years there has seemed to be a lack of an elementary text-book on the analysis of steel and steel-works materials." Is steel analysis ever elementary? It is perhaps on account of the conviction that it can be rendered so, that little or no space is devoted to theoretical considerations; the practical side of the question, in so far as manipulation is concerned, is described in detail, but the actual chemistry of the various processes involved is seldom discussed. When dealing with the volumetric estimation of various elements present in steel—phosphorus, for example—the author advises the use of a steel of known phosphorus content for standardising the solutions used for the final titration. This procedure may be satisfactory to some, but can hardly be termed scientific. Most of the analytical processes quoted are well known and fully established; when giving several optional methods the author places them in order of merit. Tables setting out typical compositions of various alloys and materials are quite a useful feature. Some of the steel analysis processes described are somewhat crude, but on the other hand the scheme of analysis for ferro-alloys is well set out; here, again, however, theory is almost entirely absent, chemical equations being practically non-existent. A work of this type will no doubt find favour in the eyes of some, but we feel that the chemist, especially the young inexperienced worker, should not only be told exactly what reagents to use and how to use them, but should also be informed as to what chemical changes take place. A routine steel-chemist who allows himself to become a mere machine will sooner or later prove unreliable.

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Scientific text-books have all too frequently been written and used as mere works of reference, and it is with satisfaction that we note that Mr. Ulick R. Evans, M.A., has produced a treatise which, while being of a encyclopædic nature, is also intended for continuous reading. "*Metals and Metallic Compounds*" is published by Messrs. Edward Arnold and Co., of London, and consists of four volumes. Vol. I, priced at 21*s.* net, is of a generalised character, and begins with an introduction in which the author has endeavoured to condense, all too briefly in the limited space at his disposal, the elementary principles of general chemistry, physics, and geology. The body of the volume is divided into two parts, in the first of which, the "Study of the Metallic State" (Metallography), the author gives a summary of the subject and deals in a general way with cooling curves, pyrometry, the effect of cold-work and annealing and describes the various types of thermal equilibrium diagram of binary alloys. "The Study of the Ionic State" (Electro Chemistry) begins with the elements of the subject and ends with a chapter on corrosion and one on radioactivity, the whole compressed into some 230 pages. The section on the colloidal state in metals and metallic compounds is perhaps the most interesting from a chemical point of view. Altogether, the first volume covers an enormous amount of ground; its general preparatory nature is clearly a necessity, however, in that it avoids irksome repetition in the subsequent volumes. Vols. II (18*s.* net), III (14*s.* net), and IV (18*s.* net) deal with the individual metals one at a time. The "periodic" classification is used; Vol. II covers the metals in the "A" group, Vol. III those in the "B" groups, while Vol. IV is devoted to the "Transition Elements." The space devoted to each metal is divided into three main sections. The first deals with the pure chemistry of the element and its compounds, the analytical side of the question being summarily discussed. The second section deals with occurrence and distribution of ores, and the third, technical in character, describes methods of extraction and purification, and finally considers the practical uses of the particular metal and of its compounds. Throughout the work references are given in the form of footnotes, so as not to interfere with

the continuity of the text. The whole work marks a distinct step forward in metallurgical literature; the author has taken infinite pains to collect and classify published information on the subjects under consideration which, in itself, is a stupendous undertaking. Moreover, he chooses his words well, and his clear style has given us an eminently attractive and readable book. Uncertainties and debatable points are tactfully dealt with; the author strives to establish practical hypotheses rather than give bewildering accounts of conflicting theories.

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Although comparatively little has been done in Great Britain either with the development of domestic water powers or with the manufacture of hydro-electric machinery for other countries, there are now signs of a considerably greater interest in this subject than has been common in the past. Our own water powers have still a difficult case to make against the competition of coal, but several important schemes have been put forward and are not unlikely to proceed in the event of a revival in trade; while on the manufacturing side it has been realised that there is no good reason why our Colonies and even foreign countries should be dependent on plant from America and the Continent, and several important firms have definitely entered the market as manufacturers of machinery of this kind. These new activities have naturally led to a larger number of engineers in this country taking a direct personal interest in hydro-electric plant than was at one time the case, and the publication entitled "*State Power Plants in Sweden*, 1921," should be both of interest and value to a considerable number of British engineers. The work has been published by the Swedish Royal Board of Waterfalls, and is dated 1921, but has reached us only this year. It consists essentially of descriptions with maps, drawings and reproductions from photographs of the four principal hydro-electric plants in Sweden—those at Trollhätten, Porjus, Alfkarleby and Notala—as well as of the steam station at Västeräs. Although no doubt some extensions may have been made at some of these stations since 1921 any change is likely to be relatively small, and the book forms an interesting and valuable document on some of the most important water power development schemes in Europe. The descriptive matter is comparatively brief, but the plans and diagrams illustrating lay-outs are on a lavish scale and are likely to be of considerable interest and value to anyone concerned with similar work. The book bears on its title page the name of Messrs. Almqvist and Wiksells, of Upsala.

## INDUSTRIAL NOTES.

THE Ministry of Labour state that the changes in rates of wages reported to have taken effect in June resulted in an aggregate reduction of over 42,000*l.* in the weekly full-time wages of nearly 370,000 workers, and in an increase of over 8,000*l.* in the wages of 75,000 workpeople. The classes of workpeople whose wages were reduced included men employed in civil engineering constructional work, skilled men employed in the ship-repairing industry on the Thames, workpeople in the gold, silver and allied trades at Birmingham. The increases in wages occurred mainly in the iron and steel trades, under the operation of sliding scales dependent on the prices of iron and steel. Iron puddlers and iron and steel millmen in the Midlands received an increase equivalent to about 5¼ per cent. on current rates, and steel sheet millmen and galvanisers an increase of about 4 per cent. on current rates. During the first six months of 1923, the changes in rates of wages reported to the Labour Department have resulted in a net reduction of nearly 390,000*l.* in the weekly full-time wages of nearly 2,700,000 workpeople, and in a net increase of nearly 112,000*l.* in the weekly wages of over 810,000 workpeople.

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The number of trade disputes involving stoppages of work reported to the Labour Department as beginning in June, was 54. In addition, 47 disputes which began before June were in progress at the commencement of the month. The total number of persons involved in all disputes in June was 99,000, as compared with 48,000 in the previous month, and 311,000 in June, 1922. The estimated aggregate duration of all disputes last June was 1,244,000 working days.

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On June 30 the average level of retail prices of all the commodities taken in account in the statistics prepared by the Ministry of Labour was approximately 69 per cent. above that of July, 1914. For food alone, the corresponding percentage was 62.

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The following comparison of wages between London, Berlin and Paris, prepared by the Ministry of Labour, the London figure being 100, will be found of interest: Mason, bricklayer and carpenter, Berlin 57, Paris 66. Unskilled labourer in the building trades, Berlin 72, Paris 82; fitter, Berlin 53, Paris 54; ironmoulder (hand), Berlin 54, Paris 55; patternmaker, Berlin 49, Paris 51; turner, Berlin 53, Paris 54; unskilled labourer in the engineering trades, Berlin 66, Paris 60. The above comparative figures can only be considered in a very general way, as allowances should be made for differences in the relative importance of the trades in the various cities, the numbers of workers employed, and so forth. The figures are based on 48 hours' work at ordinary time rates on March 1, 1923.

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The Belgian journal, *L'Echo de la Bourse*, to which we have already referred in these notes, continues to publish articles against the "little Belgians" who ignore the real interests of their country and want to prevent the immigration of foreign workmen to take the place of Belgian workmen. A great many of the latter, finding that they suffer restrictions under the socialistic regulations enforced in their country, are continuing to leave it for work in France. The journal states that at the end of 1922, the number of Belgian workmen occupied in France was 120,000, and during the present year the number leaving the country has averaged 500 per week. One has no idea, the journal adds, of the difficulties in which the lack of labour has placed the Belgian industrial concerns. Works have been compelled to restrict their production, to close parts of their shops, to decline orders, the country as a whole being the loser, simply because legal restriction of the hours of labour has led to the exodus of Belgian workmen to France. The situation is practically the same in Belgian coal mines. The foreign workmen who enter Belgium cannot be said to compete against Belgian workmen, they simply take the place of those who have left, and even they do not remain long when they learn that they can work 10 and even 12 hours in France. It would greatly interest us to know what are the opinions of the Belgian workmen's leaders in regard to internationalism. This is a fetish which appears to be worshipped in this country only.

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Dealing with the 12-hour shift in the United States steel industry, Mr. W. R. Ingalls, writing in *Mining and Metallurgy*, New York, says it seems to him that nobody should be excited about it, so long as the men who are working on such a shift are not themselves excited about it. The steel manufacturers say that there is no demand among those men for abolition of the present schedule and for the introduction of shorter hours. It is well known that even in the European countries where the 8-hour day has been decreed by law, many workers fulfil their 8 hours of work in their primary occupation and then betake themselves to another job and work some more hours. If some of the steel workers desire to work 12 hours per day for the sake of the corresponding emolument and if their physical power be not overtaxed, both of which conditions are affirmed by the steel manufacturers, there is no very good reason for meddling with things.

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At the time of going to press the dock labourers in London and Hull are still on strike. A meeting of the men was announced to be held in the East of London at the commencement of the week. Mr. H. Gosling, chairman, and Mr. E. Bevin, secretary, of the Transport and General Workers' Union, were to address the meeting. They were, however, not only refused a hearing, but also entirely repudiated by the men, who left the hall in a body. Following this, the new "leaders" addressed a letter to the employers, stating that they were now the only official representatives of the strikers, and asking for an interview to discuss the situation. This letter was ignored, and very rightly so. We may here recall that an agreement was made by the Joint Negotiating Committee of the National Docks Joint Council in September last, providing for a reduction of 1*s.* per day for dock labour as from October 2 last, and for a further reduction of 1*s.* on or after June 4, so soon as the cost of living had fallen a further 10 points. The cost of living index figure on September 1 was 79; it fell to 69 on June 1. In accordance with this, the employers put in operation the second reduction of 1*s.* per day on Monday, the 2nd inst. This was the origin of the strike. But both in London and in Hull there are signs that many of the men are desirous of returning to work under the conditions of the agreement.

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It is reported that the Executive of the National Union of Railwaymen decided at a meeting held early last week to give 14 days' notice to the London and North-Eastern Railway to apply the award of the Industrial Court known as No. 728 to railway shopmen employed on the old Great Northern Company. Failing the application of this award, the National Union of Railwaymen will call out on strike the railway shopmen on that section of the group. According to Mr. C. T. Cramp, industrial secretary of the National Union of Railwaymen, the latter body endeavoured in vain for a long time before the railway amalgamation to induce the Great Northern Company to apply the award which had been put into operation by almost all the various companies. The award No. 728 referred to is very elaborate and was given by the Industrial Court. The Court decided not to recognise district rates as a basis for railway shopmen's wages; in fixing the rates they had regard to the fact that they should not differ too widely from those paid to men in similar industries elsewhere; they further decided that general changes in the wages rates should be subject to negotiation as occasion arose; and the workshops and men were classified under several classes and grades. With regard to the notice in question, the London and North-Eastern Railway have stated that the matter concerns a number of unions other than the National Union of Railwaymen, and therefore cannot be dealt with on the application of that union alone. The other unions have made no request similar to that of the National Union of Railwaymen. On the other hand, the Amalgamated Engineering Union and other craft unions hold different views from those entertained by the National Union of Railwaymen in regard to the action of the latter union in this particular case. The craft unions and the National Union of Railwaymen, as we have repeatedly pointed out, are frequently in opposition. Both the craft unions and the National Union of Railwaymen, however, are, we believe, against any reduction in the railway shopmen's wages, although they differ in regard to the application of the award to the Great Northern section railway shopmen. Meanwhile, the London and North-Eastern Railway have asked all the unions to meet representatives of the company at a conference to consider the points at issue. The latest news which comes to hand is to the effect that the Amalgamated Engineering Union and the Federation of Shipbuilding and Engineering Trades have declined to take part in this conference with the National Union of Railwaymen and the railway company. This adds a further complication to an involved situation.

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The boilermakers' dispute has recently been under the consideration of the Minister of Labour, following upon interviews which he has had with representatives of the employers and of the Boilermakers' Society. The society asked that the dispute be referred to arbitration, or, as an alternative, that a court of inquiry be set up under the Industrial Courts Act. The Minister has replied to the society that the Act requires the consent of both sides before a dispute can be sent to arbitration; since the employers object to preferential treatment being given to the boilermakers over other unions working the overtime and night-shift agreement, and will not, therefore, agree to arbitration, he, the Minister of Labour, is unable to accede to the society's request. In regard to a court of inquiry, his view is that the dispute is not a suitable one for such an inquiry, the only purpose of which is to ascertain facts and issue a report. A solution of the dispute between the Boilermakers' Society and the Shipbuilding Employers' Federation seems, from the above, to be quite as remote as ever.

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THE ILKESTON AND HEANOR WATER BOARD.—At a recent meeting of this Board proposals were put forward for the construction of two reinforced concrete service reservoirs with a capacity of 1,500,000 gallons each, the duplication of the existing main pumping plant, which is capable of raising 120,000 gallons of water per hour to a height of 520 ft., and for the scraping of about 4 miles of 15-in. gravitation main.

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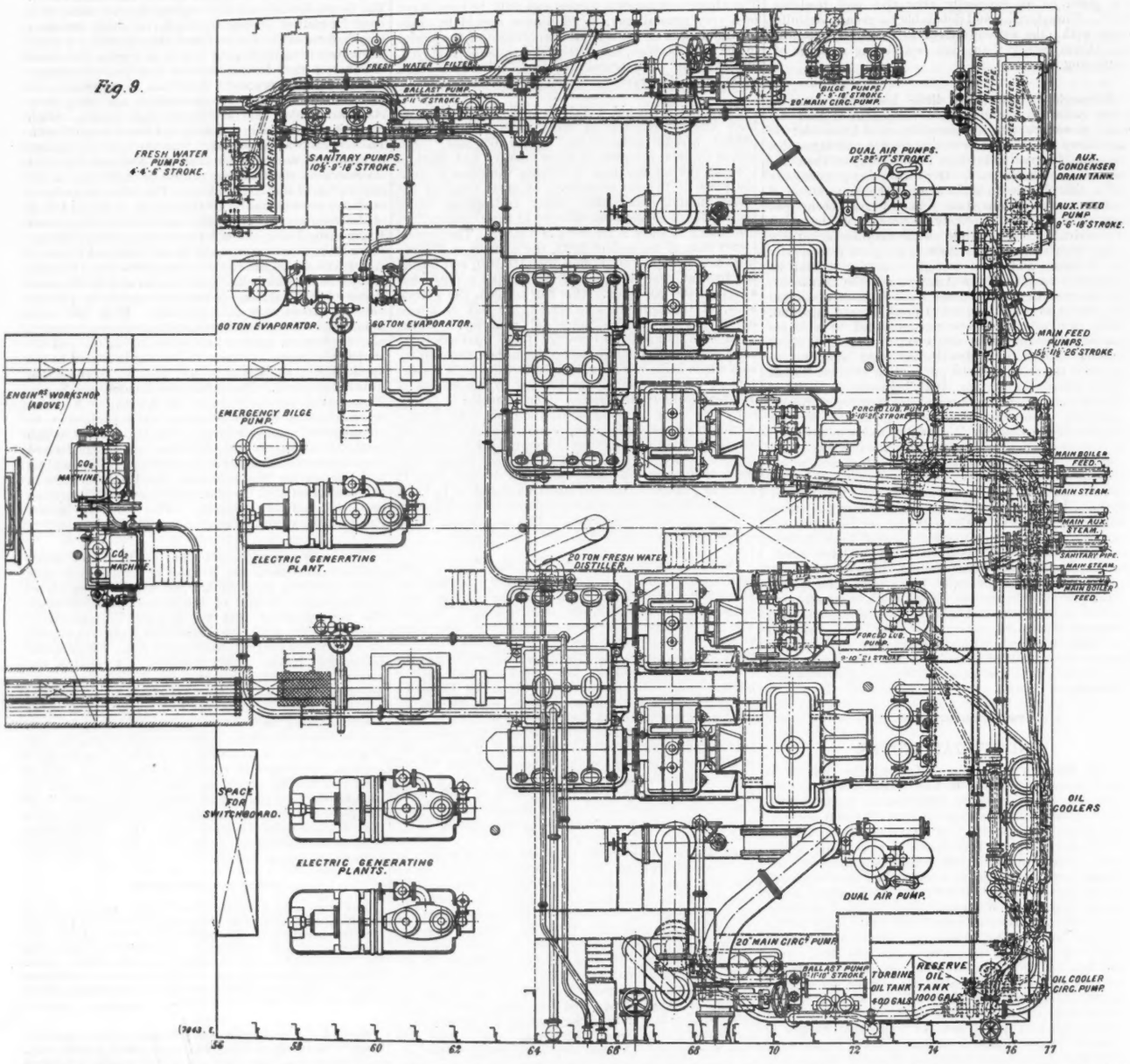
SHIPPING LOSSES.—According to returns just issued by Lloyd's Register of Shipping, the vessels totally lost, condemned, &c., during the last quarter of 1922 numbered 131, and had a total gross tonnage of 143,610. Great Britian and Ireland alone lost 23 ships, making 29,949 tons, but the latter figure represents only 0·16 per cent. of the total tonnage owned in this country. Italy comes next in order of magnitude of tonnage lost, the figures for that country being 13 ships, making 27,813 tons, and in this case the tonnage lost amounts to 0·97 per cent. of the whole Italian tonnage. The Spanish losses during the quarter are relatively higher than those of Italy, and include 9 ships, with an aggregate tonnage of 12,645, which represents practically 1 per cent. of the total tonnage of Spanish merchant shipping. The only other countries with shipping losses exceeding 10,000 tons are the United States (20,059 tons), Japan (12,101 tons), and Germany (10,041 tons), the tonnages representing 0·14 per cent., 0·34 per cent. and 0·53 per cent. respectively of the total tonnages owned in those countries. The tonnages quoted above are gross in each case and the figures do not include vessels of less than 100 gross tons. It should also be mentioned that vessels broken up, condemned, &c., from causes not consequent upon stress of weather are not included in the returns. Actually a total of 68 vessels, making 136,066 tons in all, were broken up or condemned during the quarter from other causes, and of the vessels in this category, 17, making 46,859 tons, were owned in Great Britain and Ireland. The total reduction registered was thus 279,676 tons.

# MACHINERY OF THE T.S.S. "CUBA"; COMPAGNIE GÉNÉRALE TRANSATLANTIQUE.

CONSTRUCTED BY MESSRS. SWAN, HUNTER AND WIGHAM RICHARDSON, LTD., SHIPBUILDERS AND ENGINEERS, WALKER-ON-TYNE.

*Fig. 9.*




On Plates IX, X and XI, on the present page, and on pages 113 and 116, we give illustrations of a twinscrew steamship built and engined by Messrs. Swan, Hunter and Wigham Richardson, Ltd., at their Neptune Works, Walker-on-Tyne, to the order of the Compagnie Générale Transatlantique for their mail and passenger service between France and Central America. This steamer—the Cuba—measures 476 ft. between perpendiculars, her moulded breadth is 62 ft. and her depth is 38 ft. The Cuba has been constructed to the highest requirements of the Bureau Veritas, and is moreover subdivided in accordance with the rules of the International Convention for passenger vessels. She has four complete decks, in addition to the promenade deck, boat deck and navigation deck. She has accommodation for 280 first-class passengers, 50 second-class passengers and for 250 third-class passengers and some 500 emigrants, all of whom are lavishly catered for. The safety provisions include wireless telegraphy and an ample supply of lifeboats and collapsible boats.

On Plate X we give sections and plans through the machinery and boiler room, from which it will be seen that independent compound turbines are provided for each screw shaft. These are supplied with steam by eight boilers of the ordinary marine type, 15 ft. 6 in. in diameter by 11 ft. 6 in. long and arranged for oil burning on the Wallsend-Howden system and fitted with Howden's system of forced draught. They are designed for a working pressure of 199 lb. per square inch gauge, and no superheaters are fitted. A plan of the turbine room to an enlarged scale is reproduced in Fig. 9, annexed, whilst Fig. 12, page 116, represents a section through this room taken a little aft of the forward bulkhead, and shows clearly the arrangement of valves and operating gear. A longitudinal section through the same room is reproduced in Fig. 11. The turbines were built at the Neptune works and are of the Metropolitan-Vickers Rateau type, and each set consists of a high and lower pressure turbine connected through double reduction gearing to the propeller shaft. A reverse turbine is included in each casing. The high-pressure ahead turbine has six stages and the low-pressure turbine seven. The mean diameter is 38 in. in both cases. The designed vacuum is 28 in., this figure being fixed by the consideration that the Cuba will be running for long distances through tropical waters. As already indicated above, the turbines are intended to operate with saturated steam supplied at 199 lb. per square inch (gauge).

Both the high and the low pressure turbines are designed to run at the same speed and to develop the same power, an arrangement which facilitates the construction and layout of the machinery and reduces the number of spares to be carried.

At maximum output 4,500 shaft horse-power is developed on each propeller shaft, which at this output makes 112 r.p.m., the corresponding speed of the turbines being 3,350 r.p.m. A view showing one set of turbines in course of erection is reproduced in Fig. 7, Plate XI, whilst Fig. 8 on the same page shows the double reduction gear.

In this the builders decided to adopt the Metropolitan-Vickers three-gear floating frame design. The McAlpine floating frames can be clearly seen in place in Fig. 8, and one is represented separately with its pinion mounted in position in Fig. 10, page 113. The builders were led to adopt this device because a number of failures have occurred with reduction gearing under service conditions, and it was considered that the cause of the trouble was to be found in some interaction between the teeth of the gear. In the case of double reduction gears of

# MACHINERY OF T.S.S. "CUBA."

CONSTRUCTED BY MESSRS. SWAN, HUNTER AND WIGHAM RICHARDSON, LIMITED.

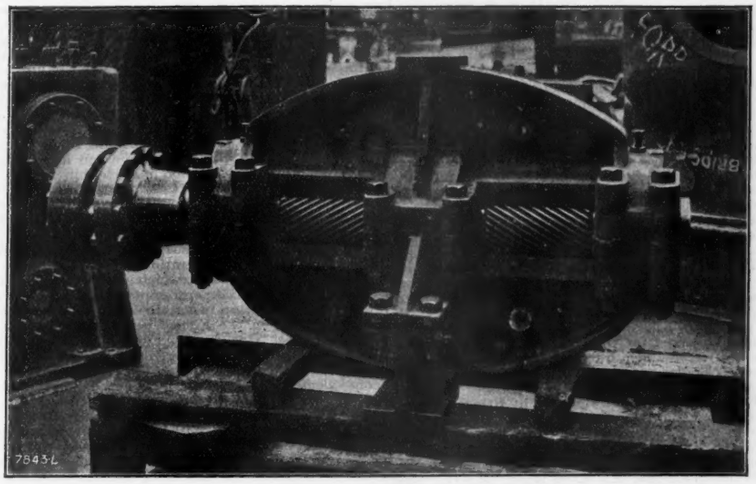


FIG. 10. FLOATING FRAME AND PINION.

the usual interleaved type, the second reduction pinion is rigidly attached to the first reduction wheel. Since the slow speed wheel is located by the main thrust block any "floating," or fore and aft movement, of the second reduction pinions must be shared by the intermediate wheels. These wheels are of considerable inertia, and inasmuch as small errors in cutting cannot be completely eliminated, the axial movement of the intermediate wheels may produce hammering of the teeth. In the Metropolitan-Vickers floating frame gear three-gear boxes are provided, flexible couplings being fitted between the intermediate wheels and second reduction pinions, as well as between the turbines and high-speed pinions. The effect of this arrangement is to allow each element of the gears to accommodate itself axially without interfering in any way with any of the other elements.

In the interleaved arrangement of gears any change in angular velocity experienced by an element of the gear must be transmitted to all parts of the installation, including the turbine. Inasmuch as the kinetic energy of the high speed rotating elements is very large these slight irregularities may be capable of producing very considerable forces at the teeth engagements.

In the arrangement shown in Fig. 8, therefore, it will be seen that an arrangement, which is virtually equivalent to three distinct gear boxes, has been adopted. There is thus one gear-box for each high speed pinion, and these are both mounted in a floating frame consisting of a short steel girder of "H" section, which in turn is attached to the gear case. This method of support provides sufficient flexibility to allow the pinion to align itself to its gear wheel under all conditions. It is possible to obtain this flexibility while still ensuring that the "H" girder is of such dimensions that the stresses to which it may be subjected are relatively low. Each second reduction pinion is similarly mounted, as shown in Fig. 8.

The following details as to weights are of interest. The total weight of two sets of turbines, each consisting of one high-pressure cylinder and one low-pressure cylinder, connecting pipes, strainers, &c., is 37 tons 10 cwts. Total weight of two condensers, including water, 27 tons. Total weight of two sets of gearing, complete, 115 tons.

During the official trials, which took place on April 11, 1923, a six hours' continuous run was made, the average power developed being 8,770 shaft horse-power and the maximum 9,210 shaft horse-power, as determined by the Hopkinson-Tring torsion meter. During this run the fuel consumption was accurately measured; the fuel used had a net calorific value obtained by analysis of 17,800 British thermal units per lb. The fuel consumption for all purposes during this run was, the builders state, 1·01 lb. per shaft horse-power per hour. When it is remembered that this is a first-class passenger vessel having the usual services in addition to the normal engine room and ship's auxiliaries, and further, that the machinery is running on saturated steam, this figure must be regarded as eminently satisfactory.

The vessel has recently completed her maiden voyage from Saint-Nazaire to Mexico and back, and throughout the voyage everything operated satisfactorily, no hitches of any kind being experienced. During the homeward run a mean speed of 15¾ knots was maintained throughout.

## THE DEVELOPMENT OF ELECTRIC LIGHTING.

IN spite of the fact that the electrical industry was founded almost entirely upon the use of the electric current for lighting purposes, there appears to have been a tendency within recent years rather to neglect this particular application and to concentrate attention mainly upon the use of current for heating, cooking and power production. Possibly the view is held that the advantages of electric lighting with metal-filament or gas-filled lamps are so obvious that they need not be pressed, or it may be that the need for equalising the load factor by increasing the heating, cooking and power connections is regarded as of greater importance than the development of the lighting load. It is, of course, true that the demand for current for an ordinary domestic lighting installation is small and of short duration in comparison with that required for a heating, cooking and power installation, but it does not follow from this that the lighting load is unprofitable to the supply companies, since the latter always employ a higher tariff for lighting current to compensate for the lower load factor.

In any case, excepting in purely industrial areas, the energy consumption for lighting alone is probably at least equal to that used for all other purposes, and, if the lighting load could be doubled in a year or two, the consequent demand for plant, switchgear, cables, lamps, fittings, &c., would tax the resources of the industry to the utmost. Even a comparatively small percentage increase in the present consumption for lighting, such as might be brought about by propaganda work, to increase the number of consumers connected and to raise the standard of illumination used by present consumers, would be followed by a welcome improvement in the prosperity of the whole electrical industry.

With this object in view, the British Thomson-Houston Company, Limited, have recently inaugurated a new department in charge of Mr. W. E. Bush, and having headquarters at 15, Savoy-street, W.C. 2, where the advantages of better lighting can be demonstrated and various problems in connection with illumination can be investigated. We recently attended a demonstration of a similar character to those which will be given in future to electrical contractors and other interested parties, so that through them the public may be made aware of the possibilities of modern lighting methods. This particular demonstration dealt mainly with industrial lighting, and after giving some figures to show that the speed and accuracy of vision is greatly augmented by a comparatively small increase in the degree of illumination, the effects of various shades and arrangements of lamps were shown, measurements of the resulting illumination being taken at numerous points in the room by means of portable photometers. The latter were of an extremely simple type which could be used by anyone without previous training or experience. The question of industrial lighting is, of course, one of considerable interest and importance in connection with works management, and numerous instances can be given to show that a material increase in output, with a corresponding reduction in the number of accidents, has followed on the introduction of improved methods of lighting. The demonstration included some examples of shop-window and domestic lighting; other phases of the subject, such as street lighting and illuminated signs, will be dealt with later.

In addition to the organisation of demonstrations, the department will be constantly engaged upon the investigation of lighting problems of all kinds and the information will be conveyed to the public by means of handbooks which will be prepared and distributed to those sections of the industry concerned with any particular aspect of the subject. The first of these handbooks to be issued deals with "Factory Lighting Designs" and contains much useful information on matters such as the quantity of illumination required for various industrial purposes, and the arrangement of lamps and shades with which any particular degree of illumination can be obtained. The British Thomson-Houston Company hope to secure the co-operation of supply companies, electrical contractors and other manufacturers of lighting equipment in this new branch of their activities, which, we think, can hardly fail to have a beneficial effect upon the industry as a whole.

## TRAMWAY TRAFFIC CONTROL.

WITH a view to minimising the possibilities of congestion on the London County Council tramway system a special system of telephones has recently been installed for the control of traffic throughout the whole area of the system north of the Thames. This area, it may be remarked, extends from Hampstead to Poplar, covering approximately 23 sq. miles and including about 53 miles of track. To run private telephone wires as ordinarily employed from all the various termini, junctions and traffic centres in such a large area to one central headquarters, would involve an installation equal in magnitude to that of a small town and the cost would be prohibitive. For this reason the Council have adopted a system which enables one pair of wires to be used for a large number of telephone instruments. The arrangement gives communication facilities equal to those of an ordinary telephone service with the usual switchboard, and has certain distinct advantages in comparison with such a system, as will be apparent later.

The scheme in question is based on the Western Electric Company's system of traffic control, and this company have been entrusted with the supply of the necessary apparatus and instruments. The Western Electric system of traffic control is already extensively used by many of the large railways in this country and abroad, chiefly for the marshalling of goods traffic, and it has also been used on a small scale on tramways. As previously mentioned, the outstanding feature of the new telephone installation is that a number of instruments may be used on one pair of wires running throughout the system. This is accomplished by a "selector" device which enables the controller to select and ring exclusively any one station out of as many as 78, if necessary, all on the one pair of wires. The number of stations connected to a pair of wires, will, of course, vary according to the particular conditions, and in the case of the London tramways only about 36 points are so connected. The headquarters for the control of the northern area is situated in the Council's car depot at Hackney, and apparatus is provided here for four controllers, although at present the traffic is being handled by one controller with very occasional assistance.

Along the track at all important junctions, special selective telephones have been fitted in cast-iron boxes mounted on the feeder pillars. At each of these junctions, a regulator is stationed, who is responsible for the regulation and spacing of the cars in the district, and by means of the telephone he is in frequent communication with the controller at Hackney. As the controller is continually receiving reports from all the regulators he is fully advised of all delays, breakdowns, accidents or other unusual events occurring anywhere over the system. The controller, by turning a particular key out of a number provided on his desk, can ring the bell of the telephone at any of the regulator or control points throughout the area, including various internal stations such as car depots, and sub-stations. He is thus able to authorise the necessary action, send the breakdown gang or bring assistance from other points; in fact, he is in complete control of the situation. When one considers the large number of minor incidents, such as breakdowns of heavy lorries on the track, which, if not quickly removed

cause congestion, not only to tram-cars but to other traffic also, it will be realised how important it is for officials to be concentrated as rapidly as possible on the scene of a breakdown.

Briefly the method of working the telephone control system is as follows: At intervals of half a mile, telephones are situated, and an official, car driver or conductor, going to any one of these telephones can lift out the receiver and shout into the mouthpiece the word "Control." This is conveyed through loud speakers fitted in the control room to the controller, who by means of a telephone jack, plugs on to the circuit from which the call is being received. The controller is also able, whilst taking the message, to ring another point such as a breakdown gang, sub-station or regulator, to whom it may be necessary to give instructions; even while he is talking it is possible for him to ring a bell on the same circuit calling another person to the line.

The system is divided up into eight circuits, which are, at present, linked in pairs, giving four separate keyboards, each of which can be operated by a single controller or the whole four by one controller. Usually the system is worked in this way, but if officials at two different points wish to hold a conversation, this line can be isolated from the other seven for the time being, and through the loud speaker the controller is able to hear when the conversation ceases. The use of the inter-connecting switches has been much greater on this system than on any of the railway installations already in existence, and it has been found that the system of tramway working is such that the Western Electric telephone control is particularly suitable for this class of work.

## SMALL KITE BALLOONS FOR SHIPS' BOATS.

TO THE EDITOR OF ENGINEERING.

SIR,—The desirability of equipping ships' boats, or a proportion of them, with wireless has been only too plainly shown by the disaster to the Trevessa and her boats. The survivors of this ill-fated ship would have had a reasonable chance of location had they had any means of communicating independently of the sunken parent ship. Many of the larger steamship companies have for some years fitted wireless to some of the lifeboats; the importance of such equipment is now all the more realised.

The suggestion I wish to put forward—and one which might deserve the attention and approval of the Board of Trade—is that ships' boats might be equipped with a small kite balloon capable of reaching an altitude of some 200 ft., the flying wire or captive wire of the balloon being the aerial for wireless from an open boat at sea. The small balloon would be folded or rolled up and stowed away, occupying no more space than a suit of oilskins. The weight complete with 200 ft. of flying wire would be about 8 lb. Charging the balloon with gas is a simple operation and occupying little time, a cylinder or bottle of compressed hydrogen, or the non-inflammable helium gas, being used. The outfit is both compact, light and simple of operation. It would have distinct advantages over masts for wireless, which are liable to be smashed in a heavy sea, and the great advantage of a high altitude and consequent increased range for transmitting, the balloon itself attracting attention in the vicinity.

A balloon of 12 ft. by 4 ft. maximum diameter would be able to rise to 200 ft. At that altitude it is in equilibrium, *i.e.*, the weight of wire lifted and the weight of the balloon itself exactly equals the lift of gas, so that it is practically a body independent of surface oscillations and conditions on the boat. Kite balloons have ridden out a gale of 70 miles and hour to 80 miles an hour. The flying wire or aerial would be wound on a small drum in a position at the lifeboat's stern, the balloon itself, upon inflation, paying off the wire as it rose.

The French air service use a small gas bottle of about 8 in. diameter by 6 ft. 8 in. long for charging lighter-than-air craft, the one charge being 215 cub. ft. The balloon for ships' boats would have a capacity of about 110 cub. ft., and could be conveniently charged from a bottle 3 ft. long and 9 in. diameter, the bottle or cylinder being slung under one of the thwarts of the boat. The envelope of the balloon would be made of either oiled silk or of cotton material gasproofed, and weighing about 5 lb., compactly stowed in a locker provided. A kite balloon is distinct from an ordinary spherical balloon. The latter cannot be flown with any stability in winds much above 20 m.p.h., and moreover, the drag is so excessive as to give little or no increase of altitude as the captive wire is paid out. With the kite balloon we have a streamlined body (at once reducing drag) and a shape having an angle of incidence to the wind so that it makes use of a dynamic lift under the envelope, assisting its own gas-lifting effort by kiting. The balloon is required to fly with its nose to the wind, and in order to obtain this condition the balloon is fitted with a rudder. This prevents spinning, as would be the case of a spherical balloon in a captive state. Two lateral rudders are also fitted at the stern. These prevent pitching and rolling. The three rudders together are therefore a means of stabilising the balloon.

Independent of wireless, a balloon might be of use for flag signal only. A distress signal flown at a high altitude would be observed at a great distance. The morale among passengers who find themselves having to take to lifeboats in an open sea would be considerably improved by the fact that their chances of succour would be considerably greater with the knowledge that their plight can be communicated from eyes, as it were, in the air some 200 ft. above the sea. It might be mentioned that one of the largest steamship lines is already interested in the proposition.

Yours, &c.,
P. H. SUMNER,
Late Staff Officer, Air Ministry.
19, Limerick-road, Redland, Bristol, July 19, 1923.

## THE LIVERPOOL MEETING OF THE BRITISH ASSOCIATION.

SUBJECT to minor alterations, the following will be the programme of Section G, Engineering, of the British Association, which is to assemble in Liverpool on Wednesday, September 12, for a full week's meeting, till Wednesday, September 19. The Sectional Committee will meet at 9.30 in the morning on all the days, except Saturday, September 15, which is kept free for general excursions. The sectional proceedings will open at 10 a.m.

On Thursday, September 13, the Section will meet jointly with Sections A, Mathematical and Physical Science, and B, Chemistry, for a discussion on Cohesion and Molecular Forces, to be introduced by Sir W. H. Bragg and Dr. A. A. Griffith, of Farnborough; the whole morning is reserved for this discussion. At 2 p.m. the Section will reassemble to discuss Vocational Tests for Engineering Trades, together with Section J, Psychology. The other afternoons are left open for visits to works.

On Friday, Sir Henry Fowler will, at 10 a.m., deliver his presidential address to the Section on Transport in its Indebtedness to Science, which is to be followed by cognate papers on Road Transport, by Mr. A. E. Berriman, of the Daimler Works, Coventry; on Rail Transport, by Lieutenant-Colonel A. E. O'Brien, D.S.O., chief electrical engineer of the London, Midland and Scottish Railway, Horwich; on Air Transport, by Major-General Sir Sefton Brancker; and on Sea Transport, by Mr. A. T. Wall, of Liverpool. In the afternoon a visit will be paid to the Works of the British Insulated Wire Company.

On Monday the following papers will be read: By Mr. J. Parry, of Waterloo, near Liverpool, on the Conservation and Control of Water Resources; by Captain J. A. Slee (of Marconi House), on Recent Applications of Wireless Telegraphy to the Mercantile Marine; by Mr. W. Barnes (of Messrs. Ruston and Hornsby, Lincoln), on the Development of the Single Bucket Excavator (illustrated by the cinematograph); by Mr. J. B. C. Kershaw, of Colwyn Bay, on Smoke Abatement and the New Bill; by Dr. Hubert Mawson, of Liverpool, on Analytical and Experimental Investigations relating to Water Turbines; and by Mr. W. J. Kearton, of Liverpool University, on the Strength of Forked Connecting Rods. A visit to the works of Messrs. Cammell, Laird and Co., at Birkenhead, is planned for the afternoon.

The first item of Tuesday, September 18, is a joint discussion with Section L, Education, on the Teaching of Dynamics, to be opened by Sir J. B. Henderson. By 11.30 the report of the Committee on Complex Stresses is to be presented, which will include papers by Professor Gilbert Cook, King's College, W.C., on the Stresses in Pipes Reinforced by Steel Rings; by Professor L. N. G. Filon, on Graphical Determination of Stress from Photoelectric Observations; by Professor B. P. Haigh, on the Thermodynamic Theory of Mechanical Fatigue and Hysteresis in Metals; by Mr. J. S. Wilson and Professor Haigh, on Stresses in Bridges; by Dr. Hubert Mawson, on Distribution of Stress in Round Bars under Alternating Torsion and Bending; and by Dr. W. A. Scoble, on the Repeated Bending of Steel Wire. In the afternoon a visit is to be paid to the Gladstone Dock.

On Wednesday, September 19, various, especially electrical, papers will be presented, by Professor E. W. Marchant, of Liverpool, on a Method of Improving the Wave Shape of Alternators, and on Triple-Frequency Currents in the Earth Connection of Three-Core Cables; by Mr. F. H. Clough (of the British Thomson-Houston Company, Rugby), on the Electric Propulsion of Ships; by Mr. R. L. Morrison (of Power Rectifiers, Limited), Waterloo-place, S.W.), on Conversion from Alternating Current to Direct Current by Means of Mercury Arc Rectifiers; by Dr. T. F. Wall, of Sheffield, on Squirrel-Cage Induction Motors with High Starting Torque and Low Starting Current in the Line; by Professor W. M. Thornton, on the Mechanism of Gas Ignition, and on a Safe Method of Lighting Coal Mines; and by Mr. J. Scott-Taggart, of the Radio Press, Limited, London, on Improvements in Wireless Receiving Apparatus, particularly for Broadcast Reception. The Section will thus have a busy week. Inquiries as to papers should be addressed to the Recorder of the Section, Professor G. W. O. Howe, D.Sc., Electrical Engineering Department, University of Glasgow.

FAN STANDARDISATION.—The Council of the Institution of Heating and Ventilating Engineers some time ago appointed a committee known as the Fan Standardisation Committee, having representatives of both fan manufacturers and users, together with representatives from the Admiralty and H.M. Office of Works. This Committee has been holding meetings at regular intervals since the spring of last year. They find that there are many difficult problems to settle, and that very considerable differences of opinion exist, both amongst the fan makers and also amongst the users, as to the correct terms to use, and as to the best method of testing fans. They hope, however, eventually to clear up all misunderstandings and ambiguities, and to issue a standard list of terms, also to define a standard method of fan testing and a clear method of listing fan performances.

## NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

*Iron and Steel.*—The downward trend of business in the finished sections is reflected in a further shrinkage in quotations relating to raw and semi-finished materials. Producers and distributors of forge and foundry iron are finding considerable difficulty in securing a market for their output over the next three to six months. Recent reductions having failed to stimulate buying, further cuts in official rates have this week been notified. If these fail to attract a satisfactory volume of purchases, output at the furnaces will have to be further restricted. The biggest cut is of 12*s.* 6*d.* per ton in West Coast hematites, delivered at Sheffield works. East Coast hematites are also marked down 10*s.*, and reductions are notified of 10*s.* per ton in Lincolnshire No. 3 foundry, 7*s.* 6*d.* per ton in Lincolnshire forge and in Derbyshire No. 3 foundry, and 5*s.* per ton in Derbyshire forge. The revised quotations are West Coast hematites, 5*l.* 17*s.* 6*d.*; East Coast hematites, 5*l.* 10*s.*; Lincolnshire No. 3 foundry, 5*l.*; Lincolnshire forge, 4*l.* 17*s.* 6*d.*; Derbyshire No. 3 foundry, 5*l.*; Derbyshire forge, 4*l.* 17*s.* 6*d.* Iron for steel-making is thus cheaper than at any preceding period this year. No alteration has been made in the price of bars and sheets, which respectively stand at 12*l.* 10*s.* per ton and 15*l.* per ton, and which failed to benefit from the improvement in certain sections resulting earlier in the year from the French occupation of the Ruhr. Makers of basic steel have lighted up more than 50 per cent. of their furnaces, but are not booking new business at the rate experienced up to the end of May. Prices consequently are on the downward grade, both hard and soft basic billets this week having been reduced 10*s.* per ton, official quotations respectively being 10*l.* 10*s.* and 8*l.* 10*s.* Belgium material is available at an average of 10*s.* to 15*s.* below local quotations, but as the quantities coming to hand are limited and are inclined to diminish local steelmakers are providing for the return of an increased demand upon their output and are putting considerable tonnages into stock. The scrap market reflects the depressed condition of special steel manufacture. Prices are lower than at any period during the last three months, but consumers decline to take more than sufficient to cover their immediate requirements. In heavy engineering sections new work of substantial character has been booked with overseas buyers for railway materials and rolling stock. Automobile sections report a steady improvement in the demand for light castings and special fittings. Makers of small tools, though badly placed on agricultural engineering account, are doing a much improved trade with automobile engineers. The file trade has booked several useful contracts during the past fortnight. Four Sheffield firms are sharing an order placed by the British Admiralty for 96,000 files. The Egyptian State railways have ordered 18,000. Inquiries are now circulating for a supplementary supply of Government account of a further 12,000.

*South Yorkshire Coal Trade.*—The output at South Yorkshire collieries is being maintained at a high level despite the hold-up of wagons resulting from failure to reach a settlement in the dockers' dispute. Export demands and new inquiries are maintained at a high level. Business on home manufacturing account, though still far from satisfactory, has been slightly stimulated by last week's price reductions. Except for special coking qualities slacks are distinctly easier, and the supplies of smalls is growing. House coal is suffering from seasonal depression. Contracts for blast furnace coke are being renewed at 26*s.* per ton, a reduction of 1*s.* on the price of the first half-year contracts. Quotations:—Best branch handpicked, 32*s.* 6*d.* to 34*s.*; Barnsley best Silkstone, 26*s.* 6*d.* to 28*s.*; Derbyshire best brights, 25*s.* to 27*s.*; Derbyshire best house coal, 22*s.* 6*d.* to 23*s.* 6*d.*; Derbyshire best large nuts, 20*s.* to 21*s.* 6*d.*; Derbyshire best small nuts, 16*s.* to 18*s.*; Yorkshire hards, 21*s.* to 23*s.*; Derbyshire hards, 20*s.* to 22*s.*; rough slacks, 11*s.* 6*d.* to 13*s.* 6*d.*; nutty slacks, 10*s.* to 12*s.* 9*d.*; smalls, 7*s.* to 9*s.*

SWEDISH METALLURGY.—The issue for June of *The Swedish Economic Review*, compiled by the Board of Trade of Sweden and published by that country's Foreign Office, states that the chief customer for Swedish iron ore and pig-iron is Germany, with England next. The exports of wrought iron and steel are more evenly distributed among the various countries, the chief importers being England, the United States, the other Scandinavian countries and France.

COMBUSTION OF POWDERED COAL.—Powdered coal has been used for those purposes which would be served by fuels of high calorific value—gas, oil or tar, says the United States Bureau of Mines. Generally, where the costs of using natural gas or oil are about the same as for powdered coal the natural gas, oil or tar is preferred. The reasons for this preference are the absence of dirt and ash, the greater ease with which natural gas, oil or tar can be conveyed and fed to the burner, and the avoidance of the equivalent of a plant for pulverising the coal. The actual flames of burning gas, oil, tar and powdered coal differ both chemically and physically. For some purposes the rapid radiation of heat from the burning particles of coal makes powdered coal preferable to other fuels, while for other purposes it is less desirable. As the art of burning powdered coal becomes better understood, furnaces and burners will be designed to enable it to take the place of oil, gas or tar for most purposes. Even to-day there are few purposes for which it has not competed with those fuels successfully, and although in some plants it has been discarded because of inherent defects, in other plants these defects have been overcome, and it has been successfully applied.

## NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

*The Cleveland Iron Trade.*—Little encouragement is ascertainable concerning the Cleveland pig-iron trade. Stocks are accumulating, and values of all qualities with the exception of No. 1 tend downward. What business is passing is chiefly on export account, and recent transactions include sales of No. 4 foundry totalling altogether a few thousand tons to Germany. No. 1 is upheld at 115*s.*, though demand is negligible; No. 3 g.m.b. is on sale at 104*s.*; No. 4 foundry is offered at 100*s.*; and No. 4 forge is steady at 97*s.* 6*d.*—all f.o.t. makers' works, or f.o.b. Tees.

*Hematite.*—A good deal of East Coast hematite has been sold to Germany, and inquiries from that country are still circulating, but other export business, as well as home trade, is very quiet, customers buying only from hand to mouth. Nos. 1, 2 and 3 are now no more than 102*s.* 6*d.* for home or overseas trade, and indeed below that figure has been accepted. No. 1 is only 6*d.* above mixed Nos.

*Foreign Ore.*—So far as is ascertainable there is absolutely nothing doing in imported ore. Best rubio is said to have been offered at 23*s.* c.i.f. Tees.

*Blast-Furnace Coke.*—Scarcity of Durham blast-furnace coke is pronounced, and the concession quotation to local regular customers runs from 40*s.* to 41*s.* delivered.

*Manufactured Iron and Steel.*—In their anxiety to secure contracts, finished iron and steel manufacturers are prepared to make price concessions, and indeed to give favourable consideration to any reasonable offers, but customers are still very cautious. The following are among the principal market quotations for home trade:—Common iron bars, 12*l.*; iron rivets, 14*l.*; packing (parallel), 8*l.* 10*s.*; packing (tapered), 11*l.* 10*s.*; steel billets (soft), 9*l.* 10*s.*; steel billets (medium), 10*l.*; steel billets (hard), 10*l.* 5*s.*; steel boiler plates, 14*l.*; steel ship, bridge and tank plates, 9*l.* 15*s.* to 10*l.*; steel angles, 9*l.* 10*s.*; steel joists, 9*l.* 15*s.*; heavy steel rails, 10*l.*; fish plates, 14*l.*; black sheets, 13*l.* 5*s.*; and galvanised corrugated sheets (24-in. gauge, in bundles), 18*l.* 5*s.*

INTERNATIONAL CONGRESS ON ARCHITECTURAL EDUCATION.—The Board of Architectural Education, Royal Institution of British Architects, announce that the International Congress on Architectural Education will be held in London from Monday, July 28, to Friday, August 1, 1924.

THE SHIPPING, ENGINEERING AND MACHINERY EXHIBITION.—This Exhibition, due to open at Olympia in September, will be the largest and most thoroughly representative exhibition of its kind yet held. Admiralty officials; port, dock and harbour authorities; steamship owners; State and other railway officials; public supply companies; heads of public works; British Consuls; oil companies; general contractors; constructional engineers, from nearly every country in the world have intimated that they will be represented.

20,000-KW. STEAM TURBINE FOR SHANGHAI: ERRATUM.—In our notice of this turbine published in our issue of July 13 the arrangements for operating the runaway valve are not correctly described in the paragraph which is printed at the bottom of the second column on page 40. As a matter of fact, in normal running the runaway valve is held open by a lever against the pressure of the spring shown above it in Fig. 10. This lever is retained in position by a trigger which is tripped by the emergency governor, should the speed rise above a certain limit, and the valve then closes under the action of the spring. The piston and cylinder shown above the valve are used in restarting the turbine, the runaway valve being opened by the admission of steam above the piston which is thus forced down against the pressure of the spring. It may further be added, that when the emergency governor trips, the main governor valve is also closed automatically, since the motion of the same lever beam which brings about the closing of the runaway valve opens a valve in the oil supply system, thus destroying the pressure under the main governor relay piston; which accordingly moves down and closes this valve also.

THE ROYAL SANITARY INSTITUTE CONGRESS AT HULL.—The Congress of the Royal Sanitary Institute at Hull opens on the 30th inst. with a reception and luncheon at the Guildhall. The subjects to be considered at the meetings and conferences are many of them outside our sphere, but we note that the "Smoke Evil" will be the subject of a paper by Professor J. B. Cohen, on Tuesday, the 31st. "Dust laying by a Colloidal Emulsion of Oil and Bitumen" is the subject of a paper on the same day by Sir G. K. Scott-Moncrieff, and Mr. G. V. Maxted will read one on "Portland Cement; Its Manufacture and Uses." Among other papers we note the following: "Reinforced Concrete in Municipal Engineering Work," by Mr. G. W. Palethorpe (August 2); "Some Modern Materials and Methods of Construction for use in Buildings," by Mr. H. D. Searles-Wood; "Hot Water Supply and Sludge Disposal," by Mr. A. J. Martin; "Percolation in Chalk," by Mr. G. F. Carter. Evening lectures will be delivered by Sir Alexander Houston on "A Pure Water Supply," and by Mr. B. S. Rowntree on "Industry and National Welfare." A reception will be given by the Lord Mayor of Hull on Wednesday evening next, and the Congress dinner will take place on Friday, August 3rd. A good programme of excursions has been arranged.

## NOTES FROM THE NORTH.

GLASGOW, Wednesday.

*Scottish Steel Trade.*—There is nothing doing in the Scottish steel trade yet and a general start will not be made before next week. Some of the works have fair quantities still on their books, but unfortunately these concerns are very few in number as the majority have actually little work to commence on when they re-open. New business is so scarce that very few contracts have been fixed up this week, and unless there is a decided improvement in bookings the amount of plant put into operation by the beginning of August will mark a considerable reduction. The matter of price is one of no little concern, but with fuel and general oncost charges so high it is difficult to see how the steelmakers can do much in the way of reductions. If only the boilermakers could be induced to return to work a certain amount of demand would be forthcoming from the shipyards which would help considerably to improve the outlook. There is no doubt that we are passing through a bad time just now and one which causes much anxiety to all, but these conditions cannot last indefinitely, and sooner or later there will be a renewal in demand, and activity will be general throughout the trade. Much depends however, on Continental affairs which are very uncertain yet, but as soon as things begin to show signs of straightening out and the rates of exchange get more normal home industries will gradually improve. Export orders are still very poor and inquiries are not very encouraging.

*Malleable Iron Trade.*—In the West of Scotland malleable iron trade things are very much as they were, as buyers have shown no disposition to again enter the market, and bookings since the holidays commenced are not reported as heavy. All consumers seem to be holding back to the very last minute in the hope of doing better than at to-day's prices, with the result that producers are placed in a very awkward position for re-starting their works. When these are reopened there is little accumulation of orders to commence on, and the old hand-to-mouth conditions are likely to prevail. Inquiries are not satisfactory despite the fact that a large tonnage must be required for the world's needs, and the moment the general feeling all round is a little more settled we can look for some expansion in local business, but not until then.

*Scottish Pig-Iron Trade.*—The holidays still being on there is no change to report in the state of the Scottish pig-iron trade. Furnaces are meantime out of action, and there is practically nothing going out. Stocks on hand are quite equal to any demands, but these are not expected to be heavy on account of the prevailing trade conditions. Inquiries for hematite or foundry iron for the home trade are very small indeed, and the same is the case with regard to shipping lots.

*Scottish Pig-Iron Shipments.*—The shipments of Scottish pig-iron from Glasgow Harbour for the week ending last Saturday, July 21, amounted to 1,062 tons. Of that total 856 tons went foreign and 206 tons coastwise. For the corresponding week last year the figures were 602 tons foreign and 139 tons coastwise, making a total of 741 tons.

BRITISH IRON AND STEEL PRODUCTION.—The National Federation of Iron and Steel Manufacturers report that the production of pig-iron in June amounted to 692,900 tons compared with 714,200 tons in April and 369,200 tons in June, 1922. The furnaces in blast at the end of the month numbered 222, four having been blown in and five having gone out of blast during the month. The output of steel ingots and castings amounted to 767,700 tons, compared with 821,000 tons in May and 400,200 tons in June, 1922.

INTERNATIONAL INDUSTRIAL STANDARDISATION.—The second unofficial conference of the secretaries of the standardising organisations of various countries of the world has recently been held in Zurich on the invitation of the Swiss Committee. On this occasion the standardising bodies of 13 countries were represented, whereas the first conference held in London in April, 1921, was attended by the secretaries of only 7 standardising organisations. Reports were received from the secretaries of a number of new bodies and a general discussion took place as to the administration and methods of working, the practical application of standards and international collaboration in standardisation. The conference is entirely unofficial and has no executive authority, but the recommendations made will be brought before the executives of the various national organisations for consideration.

CARBON AND ALLOY STEELS.—We read in *The Iron Age*, New York, that estimates of steel consumption by four leading automobile makers from 1918 to 1922, inclusive, show a total of 82,774 tons of alloy steel bars in 1918, an increase to 196,783 tons in 1920, and then a recession to 149,873 tons in 1922, in spite of the record-breaking automobile output last year. While the automobile industry as a whole cannot be judged by these few companies, the figures tend to confirm the opinion that less alloy steel is being incorporated in these particular cars. The Ford Motor Company in 1920 used 162,850 tons of alloy steel bars, but only 103,821 tons in 1922. Whatever may be the explanation in this particular case, it is a fact that the science of heat treatment has been so developed during recent years that many users of steel are finding that they can get the desired results from carbon steel when properly heat-treated, or at least can use less complicated alloy steels.

## NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

*The Coal Trade.*—The only development of interest in the coal trade during the past week has been the consideration of complaints by the coal trimmers and tippers in respect to the working of the third shift, which was brought into operation on June 4 for an experimental period of six months. At present a third of the available appliances are worked by night and gives extra employment to about 600 men. It is, however, alleged that coal which could be shipped by day is kept back for the night shift and that the volume of shipments is less than was the case when the continuous day shifts were in operation. The employers state that since the third shift became operative there has been a speeding-up in shipments which would partly account for the extra waiting time experienced by the men. At a meeting of the Cardiff Local Committee the tippers' representatives suggested that the third shift should cease, and at a subsequent mass meeting of the men instructed their delegates to a Bristol Channel conference to support a resolution demanding the abolition of the third shift until shipments exceeded by 10 per cent. those of March last. The trimmers, however, suggested that the number of appliances working by night should be reduced. At a meeting of the employers yesterday it was stated that already, as a result of the extra working hours, vessels which ordinarily did not come to the Bristol Channel were coming in consequence of the quicker turn round given to ships, and it was decided that as the third shift was arranged for an experimental period of six months the terms of the agreement should be loyally carried out by both sides, so as to give the scheme a fair trial. Under the agreement, it was pointed out, local committees were established so that either side could make suggestions in connection with shipping efficiency, and it was understood that this arrangement should continue the avenue for any representations which might be put forward. The effect of the tippers' demand would mean that exports would have to reach a higher level than has been attained in any month this year before they would be ready to work by night. In March, coastwise and foreign shipments amounted to 3,321,810 tons, and an extra 10 per cent. would mean a total of 3,653,990 tons, whereas the highest total for the year in May reached only 3,388,877 tons. Some months ago the Great Western Railway suggested that wagons used in the transport of coal from pit to port should be pooled, contending that many of the present difficulties experienced would be removed. The suggestion has been considered by the commercial committee of the South Wales Coalowners' Association, who state that they cannot agree to any scheme for the pooling of colliery wagons. Meanwhile business on the coal market continues of a hand-to-mouth character with prices irregular and dependent on individual circumstances. Some colliery salesmen are fairly well placed, but others are in need of orders. For prompt shipments best Admiralty large can be secured at 30*s.*, though some salesmen ask 32*s.* 6*d.*, while best steam smalls are round 22*s.* with other grades at relative levels. For August shipment sellers are not disposed to discount quotations and prefer to take their chance of the market which they consider will improve on smaller outputs over the holiday period.

*Iron and Steel.*—Exports of iron and steel goods from South Wales last week were the smallest for over a month. Shipments of tin plates and terne plates amounted to 6,948 tons compared with 6,750 tons, black plates and sheets to 3,866 tons against 4,478 tons, galvanised sheets to 1,576 tons against 2,202 tons, and other iron and steel goods to 2,474 tons against 6,017 tons.

THE INSTITUTION OF AUTOMOBILE ENGINEERS.—We are requested to announce that on and after Wednesday, August 1, the address of the Institution of Automobile Engineers will be: Watergate House, York-buildings, Adelphi, London, W.C. 2.

THE ROYAL SANITARY INSTITUTE.—We understand that the Right Hon. Viscount Burnham has accepted the office of Vice-President of this Institute. The 34th Congress and Health Exhibition of the Institute will be held in Hull from July 30 to August 4 under the Presidency of the Right Hon. T. R. Ferens, P.C., J.P., High Steward of Hull. Full particulars can be obtained from the secretary and director of the Institute, Mr. E. White Wallis, F.S.S., 90, Buckingham Palace-road, London, S.W. 1.

THE LATE MR. REGINALD LAURENCE.—We are very sorry to have to announce the death, which occurred on the 22nd inst., of Mr. Reginald Laurence, who was for the past 35 years chairman of Messrs. Laurence, Scott and Co., Limited, electrical engineers, Gothic Works, Norwich. Mr. Reginald Laurence was born in February, 1857, and was the seventh son of the late Mr. Sidney Laurence, of Clapham Park, Surrey. He was educated at Harrow and in Dublin, and served his apprenticeship with Messrs. Cockerill, at their Seraing Works, near Liége. The Norwich firm of which he was chairman was formed in 1888, when electricity was in its infancy and electric motive power practically unknown. Mr. Laurence was High Sheriff for Norfolk in 1921. He was a great philanthropist; as an example, we may state that during the whole of the war he and his wife made over their home at Felthorpe Hall for exclusive use as a Red Cross Hospital. This was not closed until January, 1919, by which time the original 12 beds had been increased to 23. The decease of Mr. Laurence is deeply regretted by a host of friends in the industrial world and in every walk of life.

# MACHINERY OF THE T.S.S. "CUBA"; COMPAGNIE GÉNÉRALE TRANSATLANTIQUE.

CONSTRUCTED BY MESSRS. SWAN, HUNTER AND WIGHAM RICHARDSON, LTD., SHIPBUILDERS AND ENGINEERS, WALKER-ON-TYNE.

(*For Description, see Page* 112.)

*Fig. 11.*

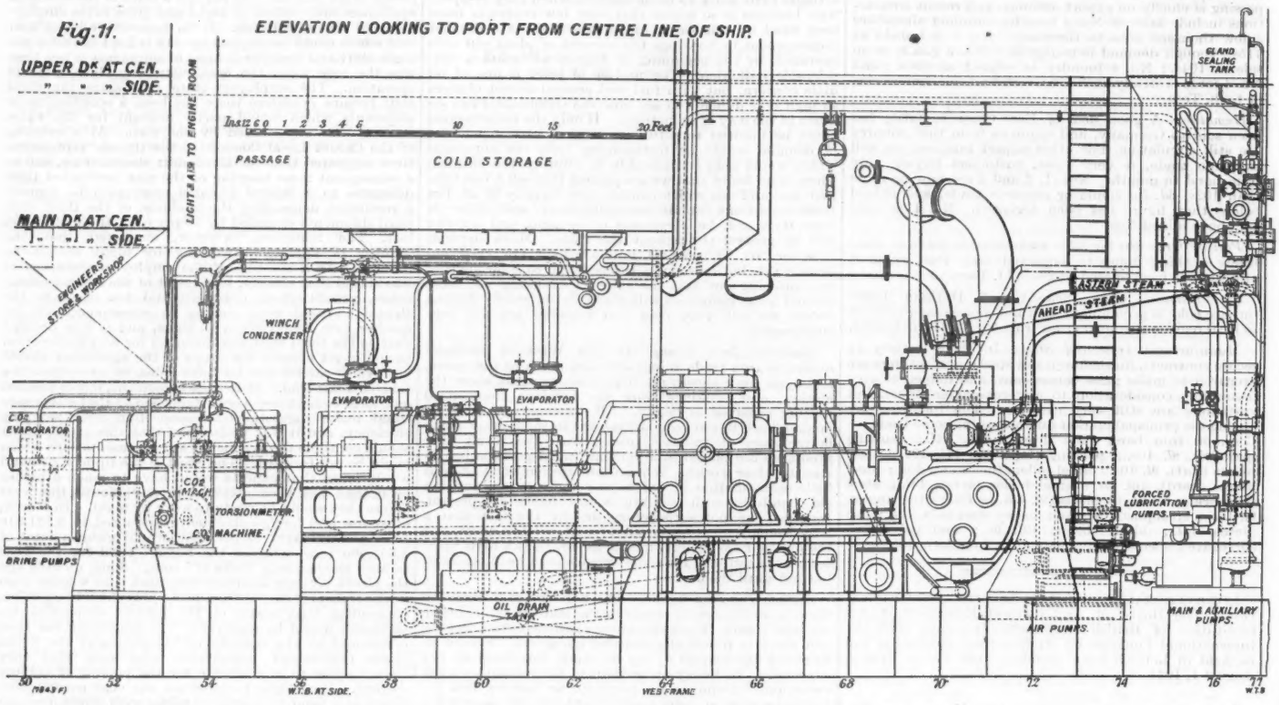
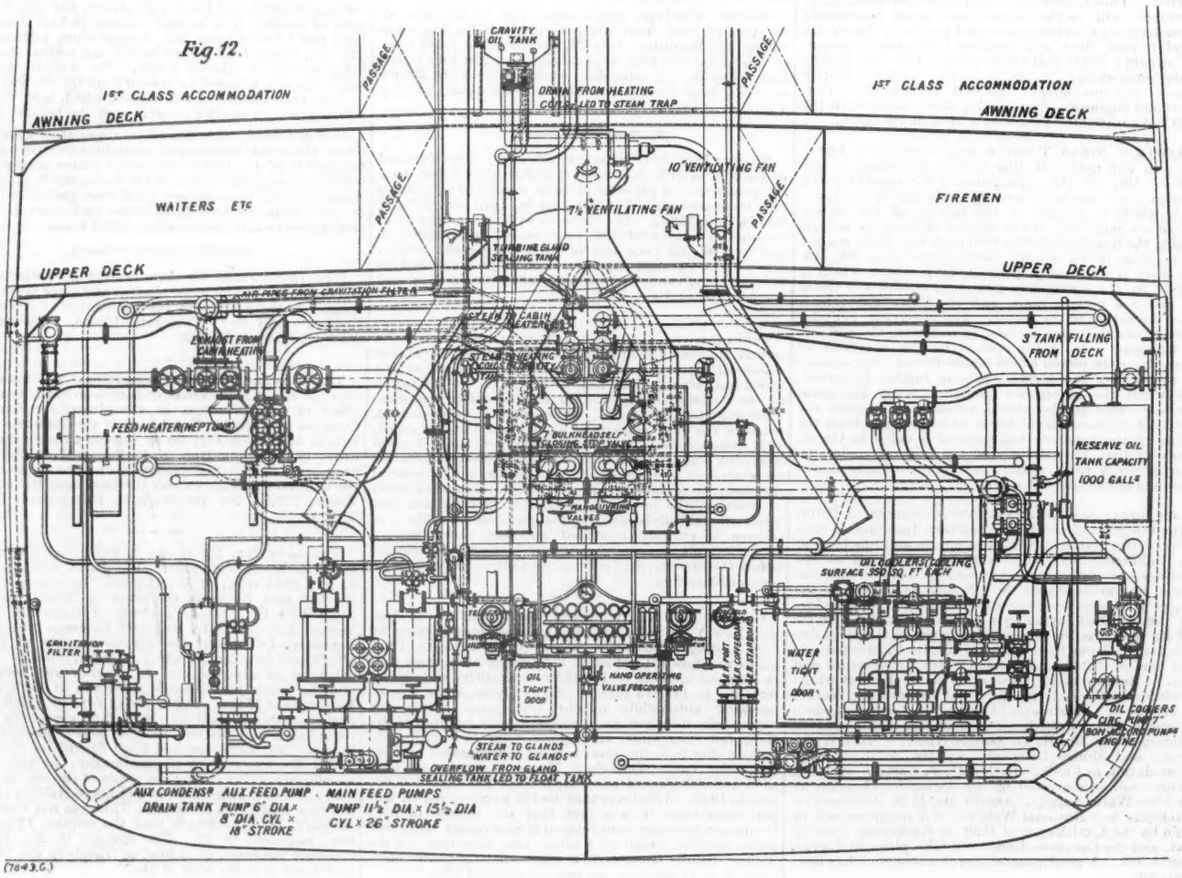



*Fig. 12.*


1ST CLASS ACCOMMODATION
AWNING DECK
WAITERS ETC
PASSAGE
CAVITY OIL TANK
DRAIN FROM HEATING COILS LED TO STEAM TRAP
10" VENTILATING FAN
7½" VENTILATING FAN
TURBINE GLAND SEALING TANK
FIREMEN
UPPER DECK
AIR PIPES FROM GRAVITATION FILTER
EXHAUST FROM CABIN HEATING
FEED HEATER (NEPTUNE)
STEAM TO CABIN HEATERS
STEAM TO HEATING COILS IN TANK
7" BULKHEAD SELF-CLOSING STOP VALVE
MANOEUVRING VALVES
3" TANK FILLING FROM DECK
RESERVE OIL TANK CAPACITY 1000 GALLS
OIL COOLERS 1ST CLASS SURFACE 350 SQ. FT. EACH
GRAVITATION FILTER
OIL TIGHT DOOR
HAND OPERATING VALVE FOR CONDENSOR
WATER TIGHT DOOR
OIL COOLERS CIRC. PUMP 7" DIA. STEAM DRIVEN PUMP
STEAM TO GLANDS
WATER TO GLANDS
OVERFLOW FROM GLAND SEALING TANK LED TO FLOAT TANK
AUX CONDENSR DRAIN TANK
AUX FEED PUMP PUMP 6" DIA × 8" DIA. CYL × 18" STROKE
MAIN FEED PUMPS PUMP 11¾" DIA × 15½" DIA CYL × 26" STROKE

(7643.G.)

(To face page 112.)

# PASSENGER AND MAIL T.S.S. "CUBA" FOR THE COMPAGNIE GÉNÉRALE TRANSATLANTIQUE.

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(*For Description, see Page* 112.)

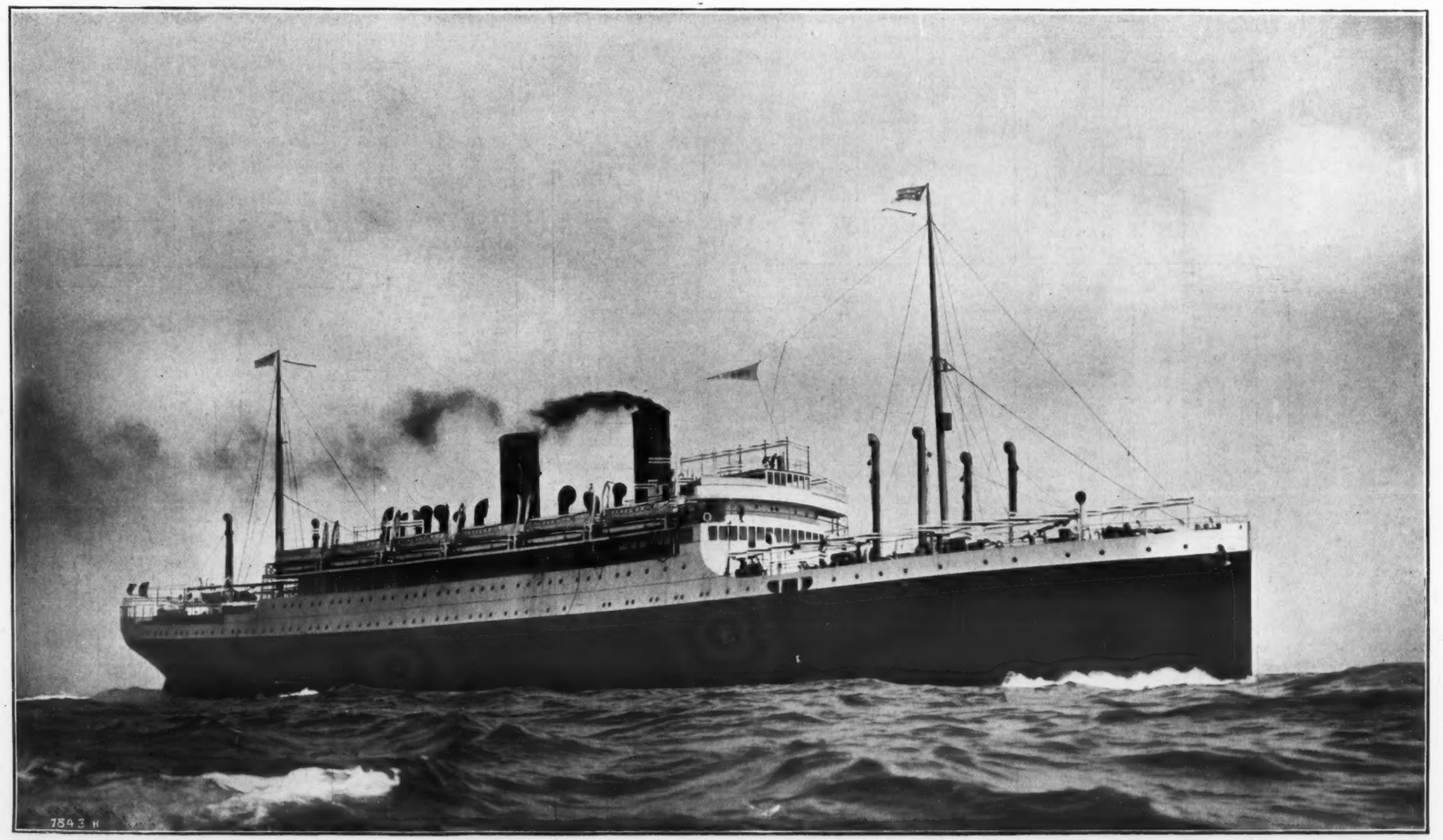



FIG. 1.

# GENERAL ARRANGEMENT OF MACHINERY OF THE T.S.S. "CUBA"

CONSTRUCTED BY MESSRS. SWAN, HUNTER AND WIGHAM RICHARDSON, LIMI

(For Description see Page 11

*Fig. 2.*

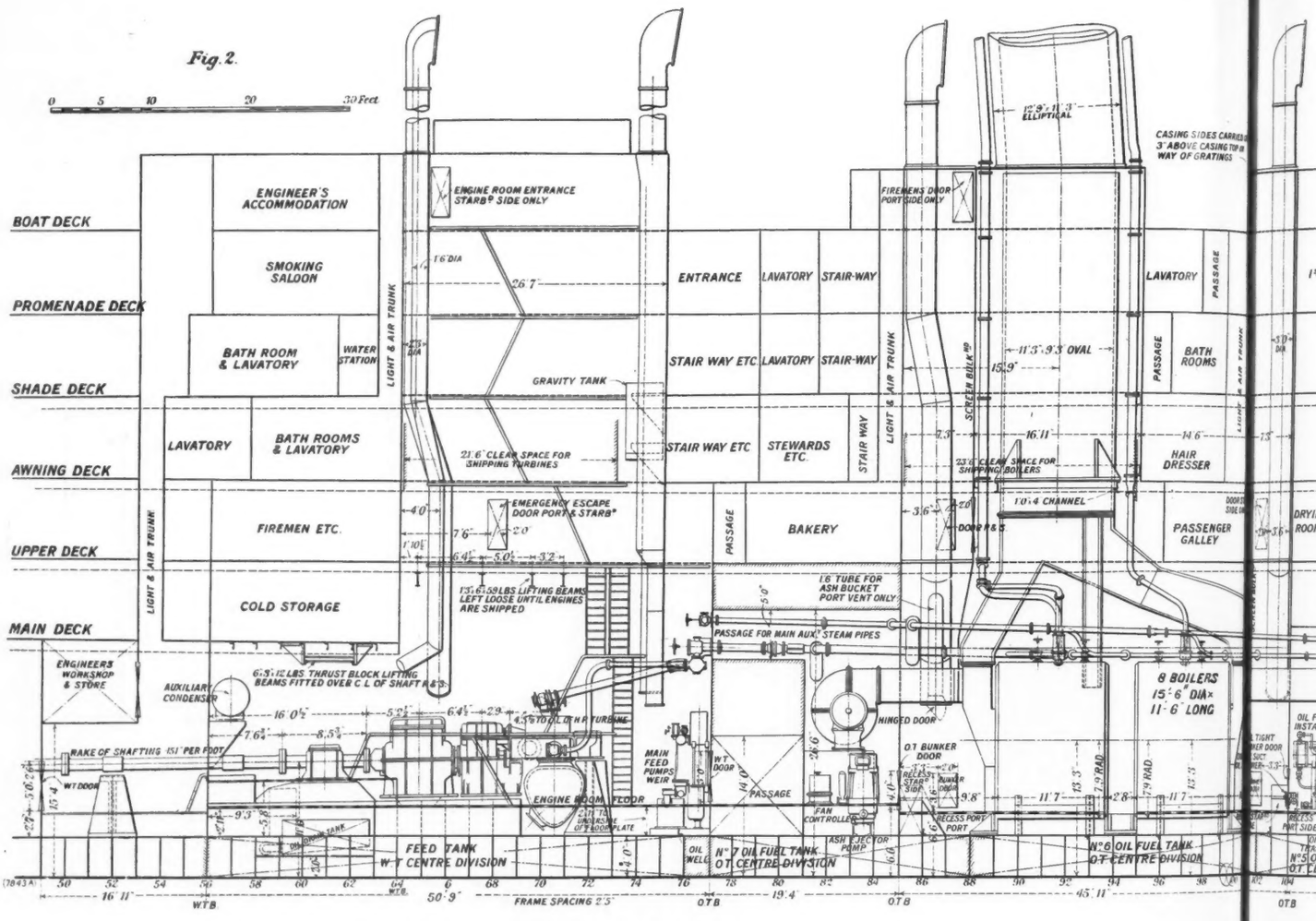
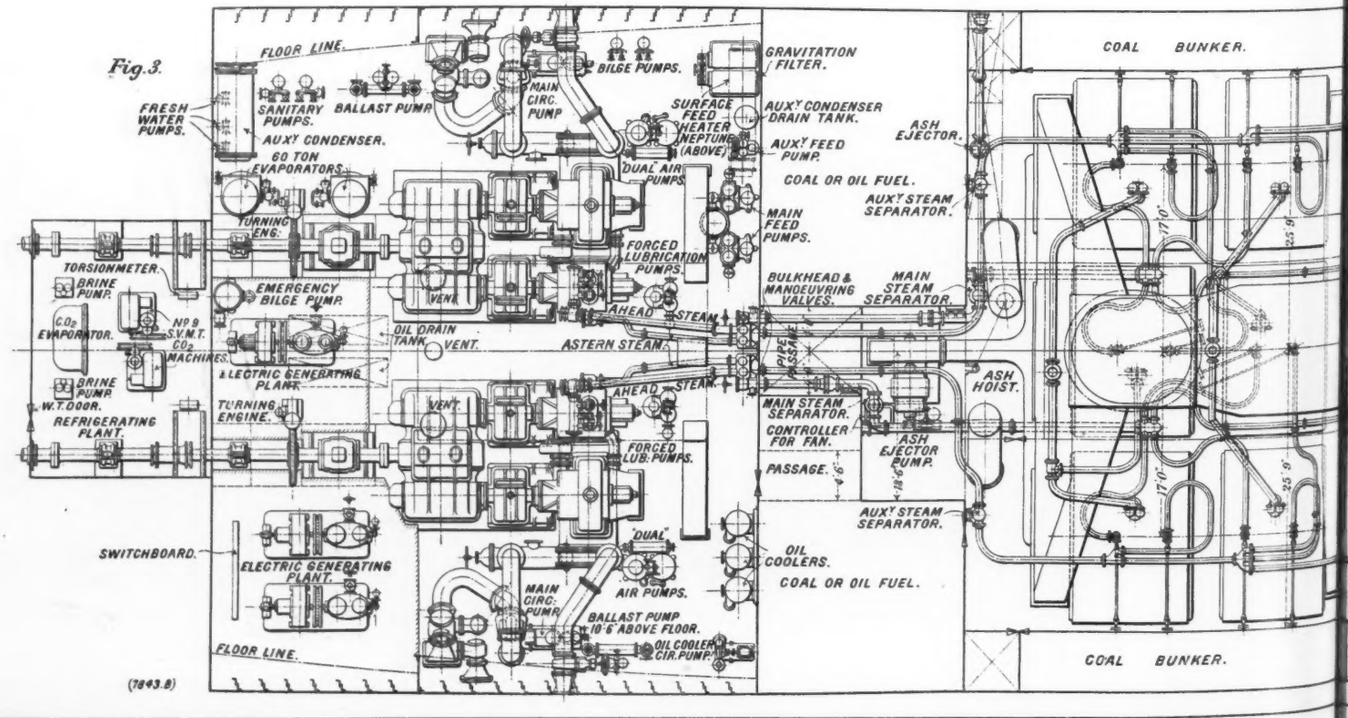



*Fig. 3.*



# S. "CUBA" FOR THE COMPAGNIE GÉNÉRALE TRANSATLANTIQUE.

I RICHARDSON, LIMITED, SHIPBUILDERS AND ENGINEERS, WALKER-ON-TYNE.

(*Description* ...*ue Page* 112.)

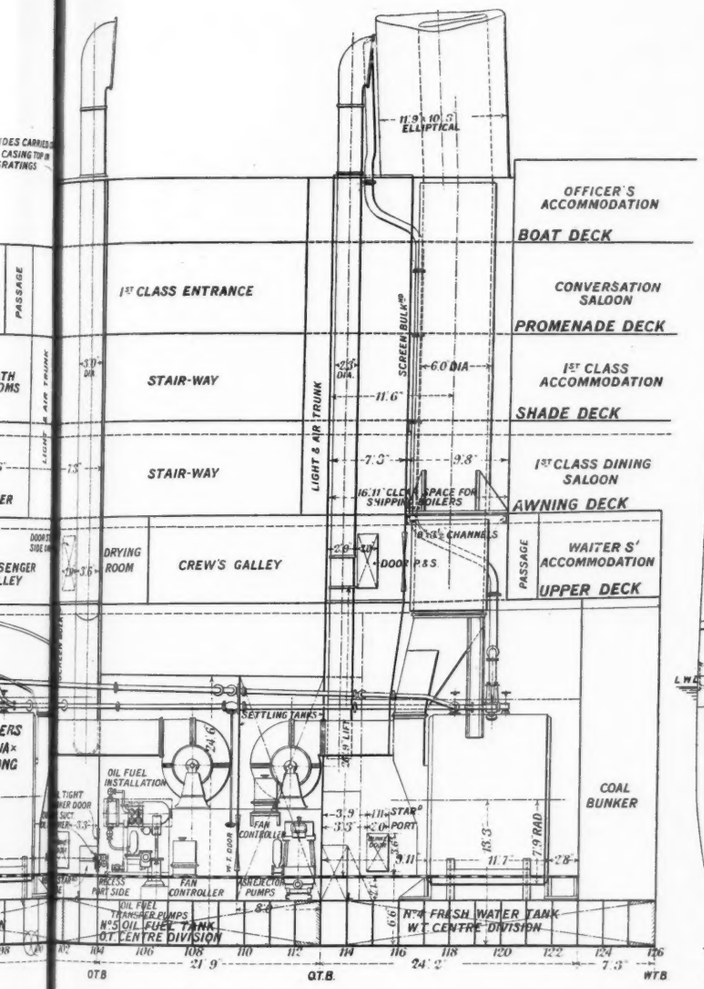



*Fig. 4.*

SECTION THRO ENGINE ROOM LOOKING AFT.

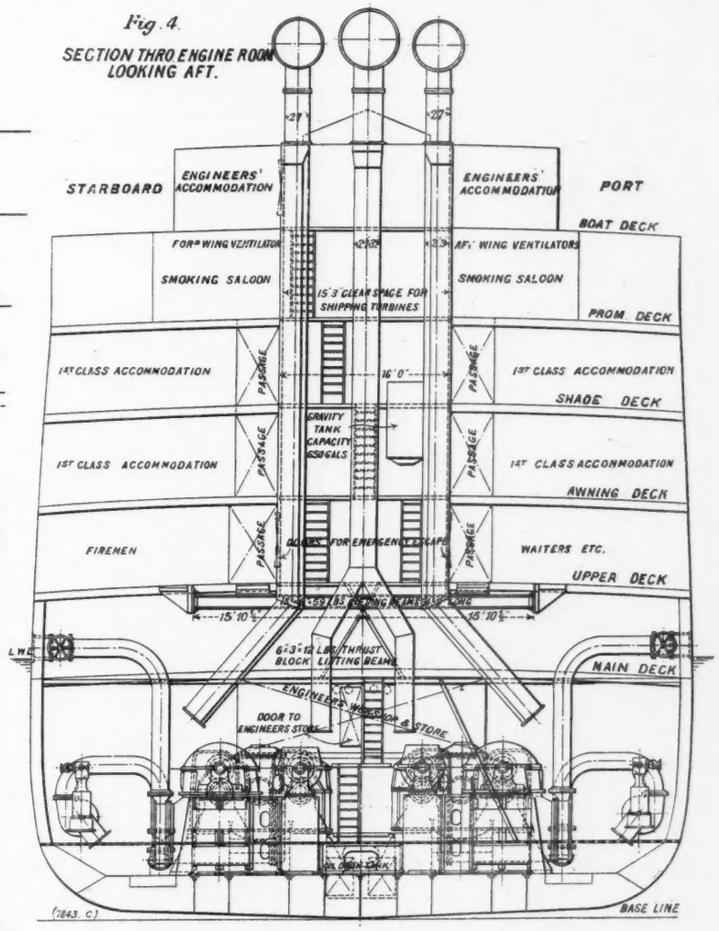



*Fig. 5.*

SECTION THRO' AFT STOKEHOLD LOOKING FORD

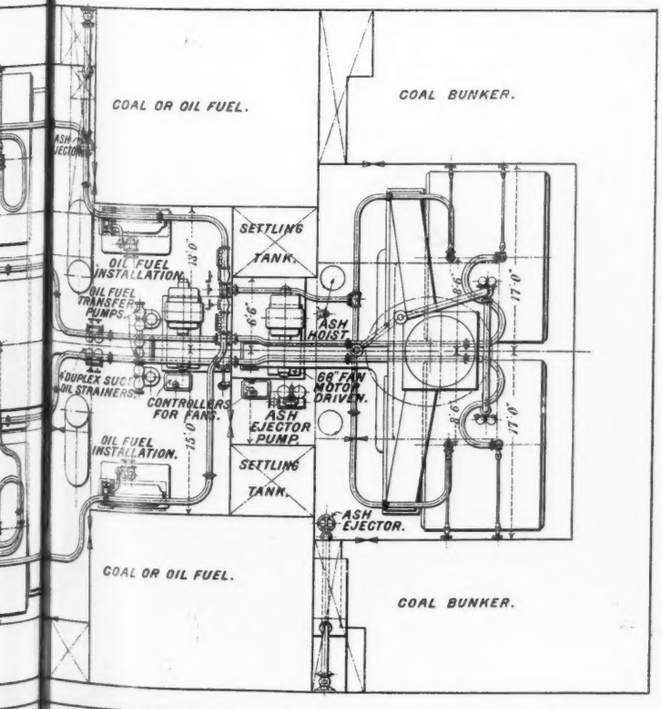
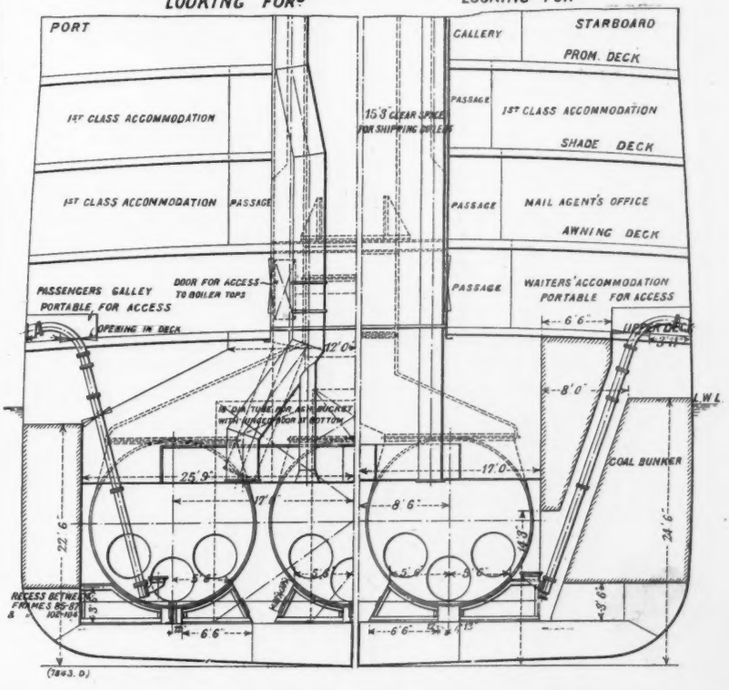



*Fig. 6.*

SECTION THRO' FORD STOKEHOLD LOOKING FORD



# TURBINES AND GEARING FOR THE T.S.S. "CUBA."

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(*For Description, see Page* 112.)

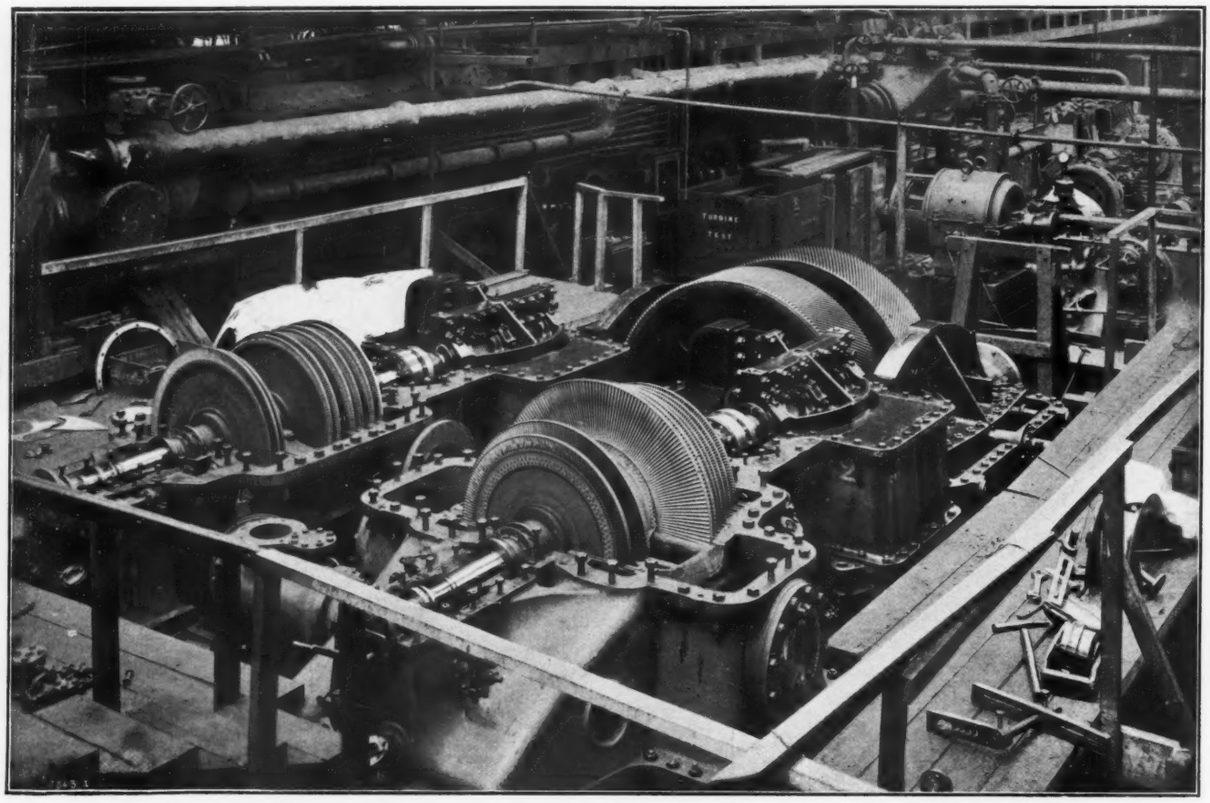

FIG. 7. HIGH AND LOW PRESSURE TURBINES IN COURSE OF ERECTION.

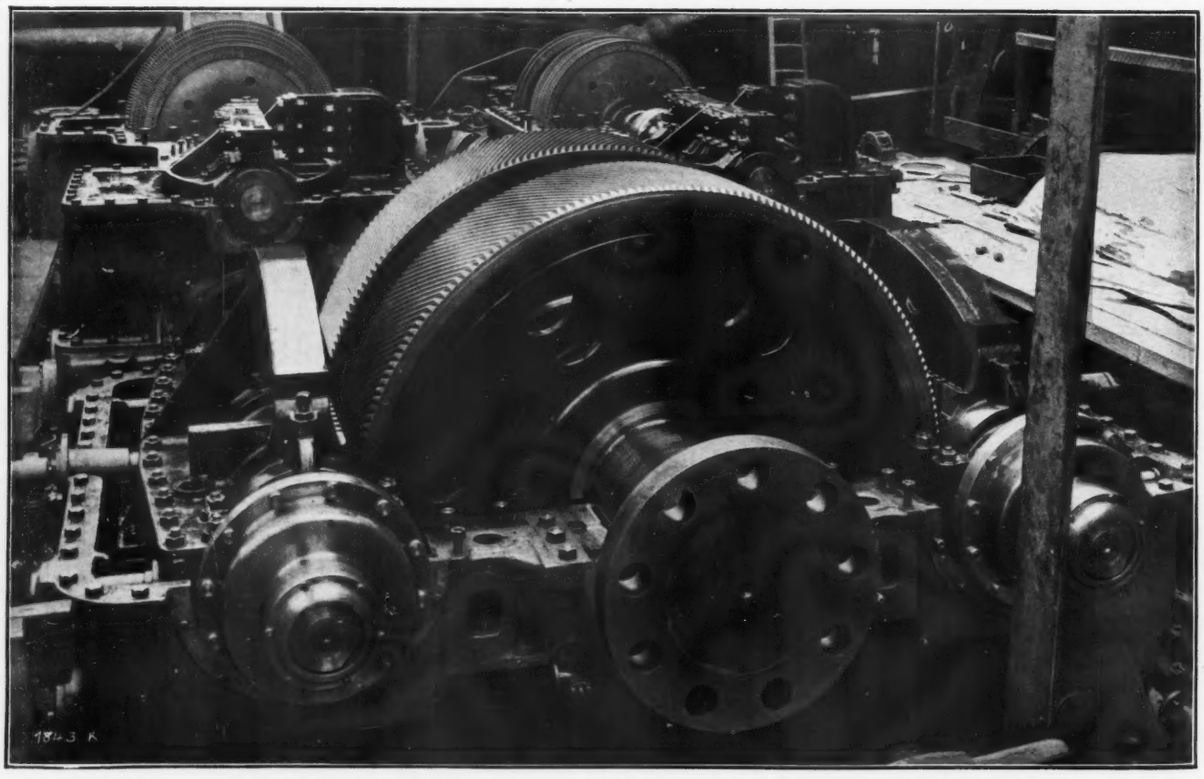

FIG. 8. FLOATING FRAME REDUCTION GEAR.

(*To face page* 113.)

# ENGINEERING.

**Offices for Publication and Advertisements, 35 and 36, Bedford Street, Strand, London, W.C. 2.**

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*Two One-Page Plates and One Two-Page Plate.*—*PASSENGER AND MAIL T.S.S. "CUBA" FOR THE COMPAGNIE GÉNÉRALE TRANSATLANTIQUE.*


# ENGINEERING.

*FRIDAY, JULY 27, 1923.*


## THE INLAND TRANSPORT OF REFRIGERATED PRODUCE.

DURING the past half-century the energies of engineers have been applied to problems of refrigeration with conspicuous advantages to the industries they serve no less than to their own. They have developed a successful practice in a previously untouched field, and the needs they have thus created have stimulated fundamental investigations in physics, chemistry and physiology, which even now are continuing to yield valuable results. Economically they have enlarged the area of supply of meat, fish and fruit to an extent that has done much towards the creation of the present standard of living, and though this country even now produces within its own borders some three-fifths or more of the beef and mutton it consumes, the balance constitutes a gigantic trade, as beneficial to the country whose present resources it supplements as it is to those colonies and friendly nations whose cultivation it promotes. The recent publication by the Food Investigation Board of their Engineering Committee's report on insulated and refrigerator barges is a reminder, however, that at the present time full benefit is not being derived from refrigerating practice. From internal evidence it is clear that the report includes only a small part of the results obtained by the committee, and a more comprehensive account of their work will doubtless appear when it has gone farther. As it stands, however, it is notable chiefly for the fact that it finds refrigerative transport by water in even a worse position than railway accommodation for the same purpose, on which it reported unfavourably in 1919.

The conditions under which meat is conveyed across the ocean are eminently satisfactory. It is brought to the ship in rolling-stock and under supervision to which no parallel is to be found in this country. At the port it is conveyed mechanically and rapidly either into cold store or refrigerator barge, if the ship is not alongside a quay and ready for the cargo, or direct into the ship's refrigerated holds. Up to the moment of shipment it has thus had no chance of being warmed to a temperature at which it could have deteriorated, and the entire refrigerating outfit of the vessel is warranted to be unexceptionable by a Lloyd's R.M.C. (Refrigerating Machinery Certificate). The conditions under which this certificate is awarded and maintained are rigorous. For the rating with cross, denoting machinery and appliances constructed under special survey, plans and specifications have to be submitted to Lloyd's for consideration, and for all vessels the machinery and appliances are surveyed and tested. Except for small vessels the motive power of the refrigerating plant has to be supplied from two or more sources, each sufficient to run the entire installation under full working conditions, and for cargo capacities above 70,000 cub. ft. (say, roughly, 700 tons of meat) the machinery has to be fitted with two or more refrigerating units. The refrigerating power of the installation must be sufficient to maintain the necessary low temperature in the cargo chambers in tropical conditions when running 18 hours a day, and unless each refrigerated chamber is connected to two or more complete sets of similar machines with interchangeable parts, of which one set is additional to the total required refrigerating power, a large supply of spare gear has to be carried. Before every voyage of more than two months' duration, or at intervals of two months for vessels engaged in shorter voyages, a loading port survey has to be held, including examination of the insulation itself to make sure that it has not been damaged, and a refrigerating test under working conditions. In addition a complete survey has to be made every six months, and for vessels engaged on voyages of three months' duration or less a further modified survey about three months later.

On arrival in this country, however, the produce ceases to have any such care as these provisions assure. For the most part it is conveyed from ship to quay in a so-called insulated barge, which may have been cleaned after discharging its last cargo, but more often has not been. If the weather is warm and the barge has for some days been used with an unrefrigerated cargo, the hull, insulation and hatches of the barge are very much hotter than the refrigerated meat now taken on board, and start immediately to warm it up, while the great size of the hatch openings admits a regular leakage of warm air into the hold, and heat flows in regularly from the water through the floor, which is seldom or never insulated at all. The meat may with luck be got into cold store within 24 hours, or the barge may miss a tide or have to wait its turn to discharge, involving a delay of 36 hours at the least before the meat is stored in a chamber at a suitable temperature ; which storage, though it may gradually arrest further deterioration of the meat as it takes up the cold store temperature, can do nothing to make good any that has occurred already, or that is still proceeding from the interior of the meat before it is again cooled. When the meat is taken out of cold store, it has to travel by van or rail ; and the conditions that it finds here are of the greater general interest because they apply also to the still larger supply of home-killed meat. Neither vans nor railway cars have any standards of design, construction or insulation. Of the two the railway cars, as would be expected, are as a rule less inefficient ; but their design for the most part is inconsistent with efficient insulation, defects in their upkeep often exaggerate those of the design, and their working is such as not to take advantage even of such insulation as is provided. The usual arrangement is for the railway companies to be responsible for providing clean cars, in good condition, for hauling them to their destination without undue delay, and for delivering them to the address to which they are consigned.

The owners, on the other hand, are responsible for loading the meat on to the cars and for their cooling and proper use, and though this duty may sometimes be taken over by the company or performed by them as an act of grace, no effective provision exists for ensuring that it is done adequately. Seldom or never, for instance, is any cooling done before the loading begins ; and the car and its insulation, like the barge that has not been precooled, is a source of heat playing directly on the

meat, and an incubator instead of a refrigerator if the meat is fresh killed and unchilled. Even if ice is provided when the loading begins, it has to satisfy the considerable heat capacity of the car and its insulation at the same time as it is lowering the temperature of unchilled contents, and the process of cooling the insulation is slow enough to allow unchilled contents to go considerable lengths in deteriorating before a preservative temperature is reached, if it ever is. In hot weather, therefore, meat is constantly being delivered at its destination spoilt or deteriorated in value. If it has not to be destroyed entirely, it has to be disfigured and depreciated by trimming off the unsound exterior, and even then may have developed putrefaction in its interior from the bone outwards.

Figures are not available for assessing the exact value of the damage caused in this way, but coupling the experience of those engaged in the trade with such figures as appear in published reports, the order of magnitude of the total loss may be taken to be 1 per cent. of the total consumption, which itself may be put at not less than 3,000,000 tons per year. the value of which would be something over 1,000,000*l*. Already, as has been seen, large sums and continuous attention are spent on safeguarding imported produce, and on the other side of the water the same care is given to inland as to ocean transport. As soon, however, as the cargo leaves the ship, and whenever and so long as it is in process of transport, there is neither systematic care nor even the means of adequately applying it. Yet to supply it would involve only a small expense relatively to the value at stake. Some items, indeed, of expense would at once produce an actual saving. Apart from avoiding mechanical damage to delicate cargo, machinery for handling refrigerated produce mechanically instead of by rough labour would save in labour and in the time of discharging the vessel much more than the cost of running the machinery, including interest and amortisation. For the cost of properly refrigerated barges and cars, of pre-cooling them, and where necessary of running small refrigerating sets, an allowance that would give the barge-owner and railway company an extra profit over and above the added expense would be much less than the value of meat destroyed or of its deterioration under existing arrangements. Underwriters, again, assured of a regular and consistent experience, could quote lower rates with more profit and less risk. Above all, the country at large, which in the long run pays the entire cost of the existing waste, would be spared a tax on its meat bill that it can ill afford.

In the last few years much time and some cost have been spent on revising the technical data of heat insulation. The researches of Dr. Ezra Griffiths and others, instituted by the Engineering Committee of the Food Research Board, which have already made important additions to our knowledge of the mechanism of heat insulation, are still in progress, and yet wider researches on the biological and allied factors of the refrigeration of meat, fish and fruits give promise of extending the already wide field of commerce in refrigerated cargoes. If the value of these researches, like that of the existing arrangements for the transport of refrigerated produce from overseas, is to be enjoyed fully, adequate provision must be made for inland transport and distribution. Dealers are in no position to test barges, cars or vans for efficiency of insulation. Some remedy must be applied to inland traffic like that which has worked so successfully and with such remarkable absence of friction with ocean-going steamers. Barge owners, railway companies and other carriers should be authorised to make a reasonable extra charge for refrigerating conveyance, and to such extent as design and inspection can assure that they supply efficient refrigeration or insulation, they should be held responsible for doing so.

## HEALTH HINTS FOR WELDERS.

TAKEN as a whole oxy-acetylene welding is not an unwholesome occupation, nor an unhealthy one. It is not particularly objectionable even in the isolated instances in which it is not possible to employ the precautions that tend to promote the operator's welfare, but under any conditions one will find men who will take a chance in spite of anything that can be done to eliminate danger or sickness. One of the main elements which the welder uses is the oxygen. This is not unhealthy, even though it escapes into the welding room in large quantities, and the welder may breathe it without fear of injuring his health. Neither is the acetylene gas particularly injurious to humanity, and when combined with oxygen it is no worse. The two elements in combination, however, producing a welding flame, create conditions that are not always favourable to the torch operator. But many of these conditions may be minimised if not entirely eliminated, and the welder can take steps to prevent the conditions from becoming unhealthy or unsafe.

One of the most obvious factors is injury to the eyesight. This is a matter which is almost absolutely within the control of the torch operators. The welding flame is detrimental in two ways. Firstly, owing to its intensity, and secondly, owing to the slow strain which may arise from continued gazing at the flame. No welder can afford to take a chance by welding without using coloured goggles to prevent the glare of light from weakening his eyes. Even if the job is a short one his eyes will be affected to some extent, especially if a large torch is employed, and if he makes a practice of doing several short jobs every day he will soon begin to note the bad results of such foolish practices. The continued strain will eventually weaken the eyes, even if the glare could do no harm, owing to the efforts to know when the metal is not melting properly. Both of these dangers may be minimised, if not actually eliminated, by the use of proper goggles.

It should be an unalterable rule for the oxy-acetylene welder always to wear coloured goggles whenever he is employing the welding flame for any purpose, and the goggles should be chosen according to the intensity of the flame. The welder should not wear one pair of goggles for all classes of welding, although many welders do this, thinking they do not have time to bother with more than one pair. The scientific operator has at least three pairs, each of different density. A deep pair for the large flame on heavy welding; a light-colured pair for the smallest flame; and one in between for the average welding job. In this way he prevents the continued peering through dark glasses in an effort to see how a small weld is progressing. In the same way by selecting the proper lenses he reduces the danger of eye injury caused by welding heavy jobs while wearing light-coloured glasses. The goggles ought to fit the job just as much as the flame and filler are selected according to the weight and size of the work.

The purpose of welding goggles is not only to prevent eye strain, however. They also protect the eyes from flying particles of metal, slag or other hot substances. This can be proved by an examination of any pair of goggles that have been in use for some time, when the lenses will be found to be absolutely covered with tiny pits or clinging bits of metallic matter. In consequence of this the best, because the most economical, kind of goggles is made with two sets of glasses, an outer set of colourless glass, protecting the inner or coloured glass from the flying particles. These goggles are made so that the outer lenses may be readily changed at any time, thus saving the expense of throwing the coloured lenses away. A supply of clear glasses should always be kept on hand because they sometimes become blurred by the tiny pits in a very short time.

Goggles of celluloid should not be worn at any time while welding on account of the danger of taking fire. In this event the operator would undoubtedly lose his eyesight before he could remove the goggles. Goggles should not only have lenses of the proper density but they should be comfortable. Ill-fitting goggles or those with metal frames often lower the welder's efficiency to a marked degree. The metal frames get hot and irritate the operator, causing him involuntarily to do a poorer grade of welding. Before leaving the subject of goggles and eye protection it may be well to caution the welder about grinding steel, iron, aluminium or other substances. Some kind of eye shields should be worn when engaged in this kind of work. Fine particles of emery dust or bits of slag when thrown by the high-speed wheel are always very painful if not very dangerous. In fact, emery dust alone when thrown into the eye will often cause severe inflammation. For grinding purposes a simpler and cheaper kind of goggle may be used. They should have clear glass of good quality, especially where accurate grinding is essential.

After the welder's eyesight, his lungs are probably the most vulnerable point of attack. As he has to work in the neighbourhood of heated and fume-poluted air a good part of his time, everything possible should be done to avert the trouble. When welding brass or other copper alloys the risks are increased and extra precautions are needed. The fumes arising from melting metals of this class are sometimes extremely injurious. Lead poisoning and brass chills are quite common in shops where much alloy welding is done. The victim often suffers several days from a single attack. Probably the worst feature is that he cannot tell when he has inhaled the poison until he has commenced to feel the symptoms, often several hours afterwards. Then his head will be racked with pain and every bone and joint in his body will ache. Sometimes nausea and vomiting will occur.

Probably the most effective method of preventing brass poisoning is to install a suction fan over the welding table in such a way that it will draw the smoke and fumes away from the weld before they can reach the welder. This exhaust should carry the fumes out of doors. Another method is to arrange an electric fan so it will blow the fumes away from the torch operator. This electric fan may also be useful in another way, by placing it so that the breeze will blow directly upon the operator when welding a long, hot job, making the heat more bearable and so increasing the operator's efficiency. Care should be taken, however, that the wind does not strike the welded casting, as a current of cold air will often cause the weld to crack through the unequal contraction thus set up.

A remedy employed in brass foundries and welding shops where much brass work is done, for the purpose of counteracting the effects of lead, zinc or brass poisoning is to drink large quantities of fresh milk; as a preventative it should be drunk before starting to weld; as a remedy it should be taken immediately after the first symptoms. As much as a quart is needed in severe cases. The fumes of the burning metal are inhaled to lodge in the mouth and throat, from where they are carried to the stomach. Then the milk counteracts the poison of the metal and thus keeps it from being carried to the whole system. Another device for eliminating the poisonous fumes of melting brass is a respirator. This is worn over the mouth and nostrils to prevent this oxidised metal from reaching the mouth and throat of the victim. Such an apparatus may consist of a rubber cup containing a moist sponge to catch the atoms of oxide and prevent them from being drawn down the wearer's throat. An ingeniously contrived valve is inserted between the sponge and mouthpiece to facilitate free breathing. A device like this is peculiarly adapted to close quarters or in places where no other precautions may be employed.

Since heat is one of the worst enemies with which the torch operator has to contend, a mask may often very effectively be employed by the welder. This device, which is really a black paper helmet, effectually protects the operator from the heat radiated by the job and intense glare of the welding, in so far as his face and eyes are concerned. Large eyeholes are provided with coloured glasses to serve in lieu of goggles which are not needed when the mask is worn. The rays of light from an electric arc weld are harmful to anyone not protected by a mask of this kind. In fact, a slight exposure of the skin to the electric rays results in a burn quite similar to the well-known sunburn even though the person is standing as far as 50 ft. away from the welder. It is said the rays will even pass through thin clothing to cause a bad burn if long continued. The mask, however, is not worn by gas welders for the purpose of protecting them from burns of this nature, but to shield them from the intense radiated heat of a heavy welding job, especially where lack of room keeps them from utilising other means of protection. The mask also serves to protect the welder's face from explosions of flying sparks or oxide while working in cramped quarters.

It might be well to add that the torch operator

who works steadily every day at the welding trade should further guard his health and eyesight with plenty of sleep. Nothing will counteract the evils of overworked eyes more than sleep. Where the eyes are straining all day, through closely watching the melting white metal, they should be given the opportunity to recuperate by sleep at least 8 hours every night. The effects of watching the welding flame and molten metal day after day may not be apparent at first, but the ultimate result is weakened vision. Perhaps it might also be well to reiterate some of the cautionary measures needed in brass welding. Where the welder cannot see the fumes he is liable to think they are not present. This leads him to take a chance and breathe some of the poison. Then, if his system happens to be able to throw it off without trouble he will take a longer chance next time. Perhaps the warnings given here are a little overdrawn, but if so it is for the purpose of causing the welder to be careful. It must not be thought that every little job of brazing is dangerous, although the direct fumes from any alloy job are laden with poison and should not be inhaled. Precautions may take a little more time or involve a little more labour sometimes, but the welder will be convinced they are well worth the trouble after he has once had a seizure of the miserable brass chills.

## "RAYLEIGH" LUBRICATION.

ONE fallacy is widely prevalent in regard to Reynolds' hydrodynamic theory of lubrication. It is often asserted that the only property of the lubricant involved in this theory is its viscosity, but the statement is due to a misapprehension; although it is true that the viscosity is the only property of the lubricant which appears in Reynolds' equations. This, however, is a very different proposition, and as a matter of fact other properties of the lubricant are necessarily involved in the premises on which these equations are founded. To form his equations Reynolds had to assume that molecules of the lubricant in contact with the metal of the bush or journal, remained fixed in position in spite of the shearing forces to which they were subjected. With very thin films such shearing forces become extremely large, and if the bond, between the molecules of the lubricant and the surface to which they adhere, gives way, the conditions assumed in framing the equations are no longer satisfied, and in actual practice, the lubrication breaks down, even although the film at the moment of failure may possibly be still many thousand molecules thick. This was strikingly shown in the experiments described in Dr. Stanton's Hawkesley lecture last winter, in which it was found impossible to carry high loads with certain lubricants, although the Reynolds' film had been completely formed and was still very many molecules thick at the moment of failure. The result of this experiment should go very far to discredit the hypothesis of some mysterious phenomenon, of boundary lubrication, of which no one has yet succeeded in devising a mechanical model. All that its advocates are able to assert with certainty is that there is a certain adsorption of the lubricant by the bearing metals. This, no doubt, is true enough, but taken *per se* explains nothing. It is asserted, indeed, that lubrication is possible with a film only one or two molecules thick, but this has not been proved, and probably never can be proved.

There is, however, one very peculiar form of lubrication to which the late Lord Rayleigh drew attention in a note communicated to the *Philosophical Magazine* in January, 1918. In certain very special conditions Lord Rayleigh found that on supplying additional lubricant to the surfaces lubricated the friction was markedly increased. It is conceivable that in this case a phenomenon is encountered which may not be covered by Reynolds' theory, and there would be no objection to the adoption of a special term to apply to this exceptional and peculiar condition.

Since, however, no physical explanation of this very remarkable phenomenon has met with general acceptance, it would be preferable to refer to it as "Rayleigh lubrication," as this would be a non-committal term, but there would be no very serious objection to terming it "boundary lubrication" if those responsible for this expression would agree to the limitation.

This Rayleigh lubrication has, however, no relationship whatever to the lubrication of machine bearings. It is impossible to run these with the mere trace of lubricant characteristic of the Rayleigh state, and the friction of such bearings is never increased by the operation of oiling, but is always reduced thereby.

In Lord Rayleigh's experiment a little tripod with glass legs having approximately hemispherical feet was placed on a glass plate and the force required to start the tripod from rest was noted. With both glass and tripod chemically clean the friction was high, but on wiping the plate with an ordinary cloth, the infinitesimal trace of grease thus supplied caused a marked diminution in the friction. On adding more lubricant, however, the friction was enormously increased, and in fact seizing occurred. Of course it would be utterly impossible to run a bearing with the infinitesimal trace of grease characteristic of Rayleigh lubrication, and hence the observation, curious as it is, would seem to have little or no bearing on practice.

## NOTES.

### GUN STEEL IN BASIC OPEN-HEARTH FURNACES.

A STATEMENT was recently made at a meeting of the Société des Ingénieurs Civils de France to the effect that in 1917 the French works manufacturing steel for 75-mm. (2·952-in.) guns by the open-hearth process started from a charge consisting generally of 10 per cent. to 40 per cent. of first-class quality Swedish or Chasse pig-iron with 10 per cent. to 65 per cent. of Swedish iron, puddled iron, or ingots previously obtained on a basic hearth, the complement consisting of gun scrap. At that time, the statement added, certain works in the Loire district deemed it impossible to manufacture steel for guns otherwise than upon an acid hearth and starting exclusively from Swedish iron with gun scrap, and in this view had stored the necessary material to the value of several millions of francs. Mr. Lucien Arbel, the well-known steel manufacturer whose works are in Northern France, has qualified this statement in the Society's proceedings; he says that since the year 1912 his works at Douai and at Couzon have manufactured steel for 75-mm. and larger calibre guns and, notably, all the elements for the first 370 mm. (14·567 in.) mortar built in 1914 at Bourges Arsenal, in open-hearth furnaces having a basic hearth, using a charge consisting simply of French hematite pig-iron and forge scrap. This process of manufacture has given perfectly regular results, the percentages of sulphur and phosphorus being below 0·04 per cent.; this same method of manufacture has recently been followed again in exactly the same conditions in the case of a series of 155-mm. (6·102 in.) gun jackets, which gave every satisfaction at the tests. Experience has shown that the steel thus manufactured in the basic open-hearth furnace is perfectly reliable in actual use, and as an instance Mr. Arbel adds that one of the 75-mm. gun tubes manufactured at his Douai works, removed from the service after firing the number of rounds considered a maximum for guns of this calibre, showed a degree of wear at the grooves below the established limit governing the removal of such a gun from the army. Mr. Arbel took advantage of the statement we refer to in the foregoing for calling attention to the possibility of manufacturing gun steel, using the ordinary type of basic open-hearth furnaces; these latter are now much more frequently met with than acid open-hearth furnaces.

### THE BREAKING DOWN OF AMMUNITION.

In an interesting lecture delivered at the Aeolian Hall, on Wednesday last, Mr. F. N. Pickett gave a brief account of the work done by his firm, Messrs. F. N. Pickett and Son, in disposing of the vast quantities of Allied and German ammunition left on the dumps in Northern France and Belgium at the termination of the war. As a result of this work, which has been carried on for about three years, and is now, we understand, completed, some 350,000 tons of material, consisting mainly of steel and other metals, has been rendered available for industrial purposes. About 5,000 employees have been engaged on the work in 10 large depots, and about 1,000,000 shells, 500,000 grenades and 750,000 fuses, weighing roughly 20,000 tons, have been dealt with per month. The first step in breaking down high explosive shells, the lecturer explained, was the rather dangerous operation of removing the fuses, but this was accomplished by placing one shell at a time in a rough cubicle buttressed with sand bags and railway sleepers and arranged so that the fuse could be unscrewed by a worker outside the cubicle using special tools. After the fuse had been removed, the charge was generally either washed out with hot water or burnt out, according to its character, but in the case of some German 42-cm. shells, the charge of T.N.T. was removed and kept. To enable this to be done the shells were cut in half in a lathe set up inside an explosion-proof cubicle and operated from outside, the operator watching the progress of the work through a series of mirrors. Large quantities of cordite were burnt harmlessly on the sea shore in batches up to 40 tons, but the stock of various noxious gases, of which 36,000 tons of cylinders and shells had to be dealt with, was more difficult to dispose of. The methods adopted for this purpose were the result of extensive experimental and research work and naturally differed according to the nature of the gas to be dealt with. Space will not permit us to refer to all the processes used, but, as an example, we may explain the method employed for dealing with the British mustard-gas shells. These were originally filled through a small hole in the side which was afterwards closed by a soft-iron tapered plug. For emptying these shells, the iron plug was driven in with a hard-steel tubular drift making a driving fit in the hole, and having the bore of the tube filled up with paraffin wax. The drift, which thus closed the hole formerly occupied by the iron plug, was left in position, and the shells so prepared were placed in trenches with the plug downwards, and covered with wood, which was fired. The heat from the fire, of course, melted the wax in the plug, and allowed the gas to escape, and being combustible it was harmlessly consumed in the fire. It is hardly necessary to add that the fuses and explosive charges of the shells were removed before the wax-filled plugs were inserted. The methods of handling shells containing phosgene and the mixture of chlorine and phosgene known as "white star" gas, were equally ingenious and effective. Large quantities of chemicals useful for manufacturing processes and as fertilisers have also been recovered, but the lecturer did not deal in detail with this part of his work. In conclusion, he expressed satisfaction that the whole area occupied by the British Armies in France and Belgium had now been cleared up, and this satisfaction will doubtless be shared by the majority of his countrymen. After the lecture a kinematograph film illustrating many of the operations described was exhibited.

### TIN-PLATE PICKLING.

During the manufacture of mild steel plates suitable for treatment in the tinning bath the surface of the steel becomes covered with scale of oxides which have to be removed by the pickling process. Two varieties of oxide scale are recognised: a heavy blue-black scale formed during the rolling-down of the bars, to be removed by the "black pickling," and a thinner layer, subsequently formed during the annealing of the plates, to be removed by the second "white pickling." The scales consist of the two oxides FeO and $Fe_2O_3$ in mixtures or compounds of various proportions; the outer layers are generally magnetic, the inner scale layers, not. Both have to be removed as the tin will only adhere to the clean metal surface. The removal is effected by immersing the plates in an acid bath, warm or cold, and it was believed that the acid penetrated behind the surface of the scale and evolved hydrogen which, in escaping, "burst the scale off." When the pickler does not observe a good seething boil from the plates, he adds more acid or steam to liven up his bath. In some works "sharps" have been added to the acid bath in the hope of reducing the acid consumption, whilst "restrainers" have also come into use in order to keep the hydrogen evolution down without prolonging the pickling process. How these restrainers acted has remained obscure and as Dr. T. Lewis Bailey, Chief Alkali Inspecto r

and the Inspector for South Wales, Mr. H. J. Bailey, could get no definite information as to the actual consumption of acid, the limit concentration and the advantages of a lively hydrogen evolution, they have investigated the whole reactions. The results of this investigation, which is described in the Alkali Inspector's Report for 1922, are most satisfactory; the reactions are cleared up, and the recommendations made have been successfully adopted in South Wales. If the acid (generally sulphuric or hydrochloric) acted upon the iron oxides alone, there should be no evolution of hydrogen; the hydrogen is evolved by the action of acid on the metallic iron and is therefore undesirable, and it has been found that hydrogen evolution is not essential and the "bursting off" theory is therefore untenable; the scale is really dissolved off, though there will always be some gas liberation. The restrainers (size as a rule) were supposed to act by making the iron surface passive, *i.e.*, insoluble. What they appear to do is that they stabilise the gas bubbles, binding them sufficiently to form a protective coating on the metal. From this point of view colloids of gluey nature like glucose, dextrin, gelatin and glue itself, in the forms of jelly and of glue, should be almost equally effective, and this was actually confirmed. There was one exception, however, cresol, which behaves essentially like glue in the froth flotation process, did not act as a restrainer at all. In all the other cases the addition of the colloid to the acid reduced the evolution of gas notably, whilst in the absence of the restrainer the gas evolution and metal corrosion increased in the course of the pickling. Size proved the best restrainer of all, especially in hot baths (up to 90 deg. C.). This is important for certain articles which must not be heated to high temperatures and these, on the addition of size, can be pickled with weaker acid. The proportion by weight of size to acid was about 1 : 7; in some cases much less size was used. Hydrochloric acid is slightly more effective as a rule than sulphuric acid. "Pickelette," a pickling agent containing organic acid, proved to be very little superior to mineral acid mixed with size. The common "sharp" used, an infusion of bran, was less efficient than size, and the bath, moreover, became turbid.

## RAILWAY PROGRESS IN PALESTINE.

THE history of the present system of the Government Railways in Palestine is an interesting one. Constructed in the first instance to meet the exigencies of the campaign in Palestine, they assisted materially in Lord Allenby's triumphal advance, and the transition from war to civil conditions on the railway was fraught with peculiar difficulties.

The birth of the present railways dates from the spring of 1916, with the advance into Palestine of the Egyptian Expeditionary Force. A full account of the remarkable work done on railway construction in Palestine during the campaign, under great difficulties, has been given in the valuable record of the Egyptian Expeditionary Force, by Lieut.-Col. H. Pirie-Gordon, wherein is shown the great part taken by the railway in the conquest of Palestine. The subsequent role played, and the progress achieved, by the General management of the railway under the civil Government since October 1, 1920, is no less remarkable in its sphere and degree—beset with its own peculiar difficulties, not least of which has been the uncertainty of the attitude adopted by the Home Government. The manner in which the work has been carried out in the face of the political unrest, and the campaign in the Press which has frightened away capital, is worthy of our highest Colonial traditions. The following account of the transition has been supplied to us by Capt. Ray, C.M.A., Accounts Officer, Sinai Military Railways.

On October 1, 1920, the War Department transferred the railways within Palestine to the Civil Administration, together with the working rights over the Kantara-Rafa section, which is in Egyptian territory. This whole system is indicated in the accompanying map. It should be borne in mind that the railway was laid in the first instance for military operations and that speed of construction was a primary necessity. This was attained, but to a certain extent at the expense of the bridges and culverts, which were of a semi-permanent nature, with much timber trestle work and improvised abutments and piers of timber and sandbags. Considering the rapidity with which these were erected, they have served their purpose wonderfully, and the majority of them are still standing, although with improved permanent masonry, abutments and wing-walls.

Again, although the banks were constructed in most cases to standard practice, the cuttings were insufficiently drained, and this, in conjunction with lack of ballast, gave considerable trouble in the wet seasons. Both during the winters of 1917–18 and 1918–19 washouts and damage to the main line resulted from the rains, but it was not till the winter of 1919–20 (admitted to be exceptional by the inhabitants) that it was fully realised how inadequately equipped the line was to withstand really heavy rains. Washouts of unprecedented magnitude occurred at different points between Migdal (Km. 263) and Khudeirah (Km. 366), but more particularly at Ashdod (Km. 275), Yebnah (Km. 290) and Ras-el-Ain (Km. 324), and in spite of all available labour (both Egyptian Labour Corps and military) requisitioned for repair work, the line was cut at one time for a period of 10 days on end.

When the Civilian Government replaced the Military Administration in the summer of 1920, the question of ensuring the railway line against further damage from floods was seriously considered and an extensive programme to include drainage and protection works, ballasting of track and bridging, was put in hand immediately, with very satisfactory results. During the two following winters, 1920–21 and 1921–22, only three washouts occurred, whilst during the winter just past, no damage has been occasioned at all.

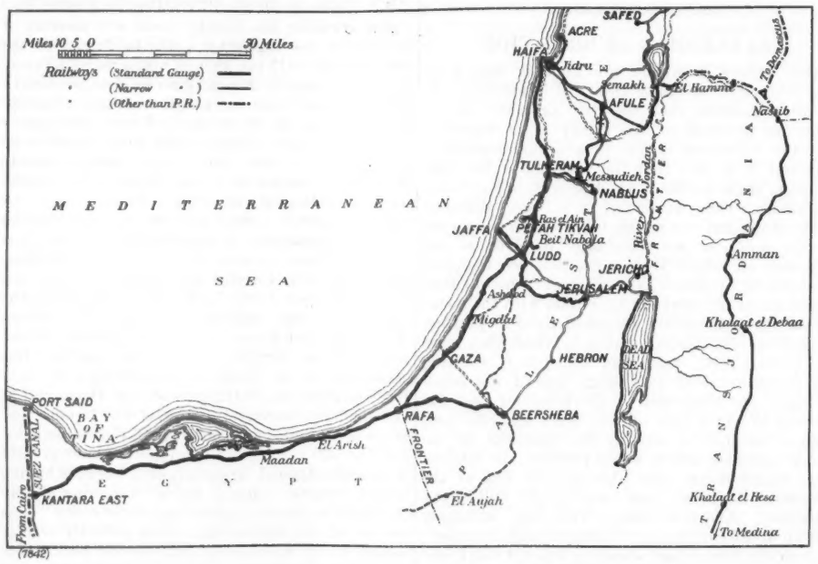
During these last two and a-half years (and more particularly in the latter half of 1920) not only have the military bridges and culverts been improved and strengthened, but more than 20 new bridges of permanent type and of spans varying from 12 ft. to 120 ft. have been constructed, mostly under traffic. All the existing bridges on the old Jaffa and Jerusalem line have also been strengthened to carry the heavier locomotives necessitated by the increased loads to be hauled up the heavy grades of that section.

Stone ballasting of the main line was started in the summer of 1920 and continued until February, 1922, when owing to lack of funds, further work had to be postponed. During this period 160 kilometres of main line track were ballasted with stone obtained from and crushed at a special quarry opened up near Tulkeram (Km. 348). Drainage of cuttings and other protection work of a similar nature has been carried out continuously, first with specially-engaged labour, and later with prison labour recruited from the local jails. New station buildings, both of permanent and semi-permanent type have replaced the temporary hutments at the various main-line stations. Ludd (now called Lydda) station, the main railway junction of the system, has been entirely remodelled and brought up to European standards, with station buildings, buffets, paved platforms and subway.

Branch lines have been constructed to the military cantonments at Surafend and Jenin, and to Beit Nabala Quarry and to the Jewish Colony of Petah Tikva, the centre of the orange trade. These lines approximate nearly 20 kilometres in length.

The Sinai Military Railway desert section between Kantara and Rafa, which was doubled in 1917, before the advance into Palestine, has since been converted back to single-line working, and its original alignment altered at six different points, which were considered particularly dangerous to fast traffic, owing to grading and curvature. A portion of the line rendered dead by the conversion to single-line working was taken up and relaid between Ludd and Haifa on the Palestine Railways, where the rails originally put down by the military were very old and worn.

After the Armistice the question of the temporary railway bridge over the Suez Canal being left *in situ*, became urgent, but the Suez Canal Company




adhered to its rightful claim to have the bridge removed, and it was finally agreed to close it on December 31, 1920. This necessitated the extension of the Sinai Military Railway main line to the canal bank and the erection of a new passenger station immediately opposite the Egyptian State Railways Kantara station, with which it was connected by the military pontoon bridge. This station was opened on January 1, 1921, and passengers for Palestine had, from that date, to cross the bridge on foot until the summer of 1922, when the pontoon bridge was replaced by the chain ferry now operating. The new station has been fitted with every convenience for passengers. Goods wagons are still transferred from the Egyptian State Railways to the Sinai Military Railway and *vice versa* by means of the pontoon traverser which has been in operation throughout.

The rolling-stock left by the Army was necessarily in a worn-out condition and required heavy repairs and reconstruction to meet the requirements of a civilian concern. The railway has now been equipped with new engines, and rolling-stock of the newest and most comfortable type, equal to any European railway, and able to cope with local traffic and any number of visitors to the country.

Tourist traffic was inaugurated in 1921–22, and although the railways were handicapped by lack of rolling-stock, and had to borrow from the Egyptian State Railways, the season was nevertheless an unqualified success, and the arrangements for the comfort of tourists elicited numerous testi-

monials of approbation. Catering for the feeding of tourists was carried out by the International Sleeping Car Company, whose cars are attached to all through trains on the Kantara-Jerusalem-Haifa routes. Buffets controlled by the Railway Provisioning Department also catered for their needs at all main stations.

The success achieved in this first season justified the hope that the 1922–3 season would prove even more successful. Unfortunately, the conditions in the Near East have prevented this, as many intending visitors cancelled their trips. The result has been, therefore, on a more moderate scale. With more settled conditions, the tourist traffic is capable of great expansion, both from distant and adjoining countries.

The ordinary passenger traffic is catered for in an equally progressive manner, but the railways have been seriously affected by motor car competition. The motor-car industry was helped in this direction by the excellent roads provided by the Government, which, unfortunately, run parallel to the railway, and compete with, instead of feeding, the railway to the mutual benefit of all methods of transport. It is, however, anticipated that the reduced fares which have been put into force from April 1 will improve the situation of the railways by securing to them their due share of traffic and give a great impetus to trade.

The passenger rates in force from April 1, 1923, are as follows :—

| | 1st Class. Milliems per Kilo. | 2nd Class. Milliems per Kilo. | 3rd Class. Milliems per Kilo. |
|---|---|---|---|
| Jaffa-Jerusalem line... Tulkeram-Nablus line Haifa-Acre line ... | 6 | 4 | 2 |
| Petah Tikvah-Jaffa line All other sections ... | 9 | 6 | 3 |

One milliem = one farthing. Kilometre = $\frac{5}{8}$ of a mile.

Goods traffic has been curtailed in volume by the general world depression in economic conditions, which it is hoped are now improving, and the rates have been reduced considerably to encourage and assist the revival of trade. In a general way all war-time increases which ranged from 50 per cent. to 200 per cent. over pre-war charges have been reduced to a uniform 50 per cent., while commodities which are essential to the welfare of agriculture are now carried at pre-war rates, and in the case of oranges, the staple article of export, the rates have been reduced still further.

One exceedingly satisfactory feature in the transport of goods is their practical immunity from pilferage while in the custody of the railways. This is the result of the excellent measures adopted to obtain security. The speed and punctuality of the passenger trains have been brought up to a high standard, and the staff exhibit an improving sense of responsibility and civility to the public. The safety of the travelling public is satisfactorily ensured by up-to-date appliances and the vigilance of all concerned.

## THE NATIONAL PHYSICAL LABORATORY.

(*Continued from page* 94.)

*Structure of Metal Crystals.*—In studying the structure of metals and alloys by the X-ray spectrometer, Dr. Owen and Mr. Preston (of the Metallurgy Department) use neither definite crystals, nor powdered material compressed to a thin pencil or pasted in a streak on paper, but substantial plates, 5 cm. by 2·5 cm., cast or rolled and submitted to such a thermal treatment that crystals about 1 mm. across will be formed in the surface layer, which, after etching, is finally smeared with vaselin to prevent oxidation. The K radiations from an anti-cathode of rhodium (or molybdenum, &c.) fall upon the plate and are reflected into an ionisation chamber; both the plate and the ionisation chamber can be turned, and when preliminary experiments have shown a prominent deflection at some definite angle, that region is further studied. The idea is that crystals will in the plate, as in a powder, be oriented in all directions so that reflections of the K rays (both $\alpha$ and $\beta$) from all the crystal faces will be obtained, subject to the law that $n\lambda = 2d \sin \phi$, where $\lambda$ is the wave-length reflected, $n$ the number of parallel planes, at distances $d$, taking part in the reflection from the respective face, and $\phi$ the angle of reflection. When the sin $\phi$ are plotted against the reciprocal of $d$, a pencil of straight lines, all passing through the origin of the rectangular co-ordinates, is obtained, in the case of cubic crystals, each line corresponding to one crystal face and one radiation, such as 111 $\beta$, 111 $\alpha$, 100 $\beta$ 100 $\alpha$ . . . where the numerals indicate the axial ratios of the faces. The $d$, which does not differ much for different elements, can then be calculated.

The work is simpler than might be thought. With currents of 1 milliampere an observation takes 8 seconds and a spectrum can be plotted in 1 hour, whilst it would require many hours and currents of 300 milliamperes by the photographic methods. The cubical crystals of iron, copper and aluminium have given such diagrams, on which all the lines looked for are found. The diagram of the hexagonal crystals of magnesium is not so simple. Metals can be identified by their X-ray spectra; in their alloys the lines appear shifted, the $d$ changing slightly. The crystal lattice of copper opens out, when an aluminium-copper alloy is formed because the aluminium atom has a bigger volume than the copper, and the cubical model of the alloy appears distorted. Alloys of copper, nickel, magnesium and silver have been studied by this very promising method.

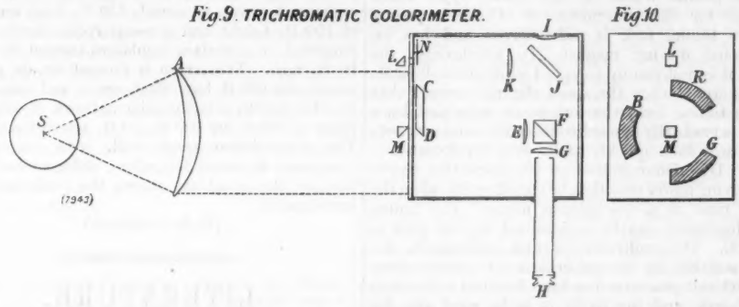
*Sound Division.* (Dr. Kaye, Mr. A. H. Davis.)—The equipment of this new division, quartered in Victoria House, has been proceeded with, especially in connection with the study of the acoustical properties of buildings, of building materials, and of loud-speaking telephones. A number of Endelmann whistles have been standardised. This whistle is a pipe closed at one end by a plunger, the position of which is determined with the aid of a micrometer screw; the whistle is blown either through a rubber bulb or by compressed air at known pressure. For frequencies up to 15,000 per second the whistle is calibrated by comparison with a three-electrode valve on the beat method; for higher inaudible frequencies extrapolation is resorted to, standardised Endelmann whistles form a convenient portable source of high-pitch sounds.

*Optics Division.* (Mr. T. Smith, M.A.; Mr. J. Guild, Dr. J. S. Anderson, Miss A. Everett and Miss L. M. Gillman.)—The increase in the number of telescopes submitted is largely due to the insistance of the Admiralty upon the water-tightness of service gunsighting telescopes. That involves revised tests which the instruments do not yet always pass. The numbers of sextants and theodolites were still below the averages of the previous years. For the researches on polarimetry a standard polarimeter and saccharimeter has been purchased from Messrs. Adam Hilger; there is a discrepancy between the Teddington standard and some foreign standards.

*Research. Spectrophotometry and Colour Standardisation.*—When spectrophotometric observations are made the basis of colour calculations, the radiations of low visibility from the ends of the spectrum, of little importance for luminosity determinations, become important on account of their high colouring value. In mixing red, green and blue, for instance, very little blue, as measured by its luminosity, is required to make white. From this point of view the Koenig-Martens spectrophotometer, though preferable to the Nutting instrument, was not found sufficiently accurate. A special spectrophotometer has hence been constructed in which, by the aid of two collimators and a special prism, partly triangular and partly parallelopiped, the beam is so split as to give a central field, due to the one collimator, between an upper and a lower field, due to the other. The brightness of one of the beams is varied with the aid of a double photometric wedge of lamp-black in gelatin; this wedge has to be calibrated *in situ* owing to light scattering.

By the aid of Mr. Guild's new trichromatic colorimeter, which was mentioned last year [ENGINEERING, July 28, 1922, page 122), any colour can be standardised and be analysed in terms of visual sensation. The principal of this instrument is explained by Figs. 9 and 10. The source of light S, a 500 c.p. pointolite lamp, is placed at the focus of the large lens A, which throws a beam normally on the one face of the colour mixing box; Fig. 10 shows that face as seen from S. Three arcs are cut out of the face, each of about 60 deg.; the arcs are backed by ground glass and sheets of coloured gelatin filters (red, green, blue) and can more or less be obscured by sectorial shutters. The prism C D rotates, about an axis which would coincide with the line D E; during this rotation the end of C passes over the arcs; the lens E is so placed that the effective stop, a hole in the frame of C D, is at its focus; F is a Lummer-Brodhun photometric prism, and G a lens which has its focus at H. The observer at H sees the colours mixed when the system is rotated. The specimen to be matched is placed in front of the window I; J is a plate of plane glass which has been introduced, together with the lens K, the prisms L and M and the annulus N (of gelatin-black) to admit of diluting highly saturated colours with variable amounts of white light.

*Fig. 9. TRICHROMATIC COLORIMETER.* *Fig. 10.*




Important papers on the types of optical setting, on optical calculations and observations, and on the theory of instruments have been compiled by Mr. T. Smith and other members of the staff, and these as well as the series of tables in the course of preparation will shorten the time to be spent upon ray-tracing and design.

*Optical Workshop. Constant Temperature Room.*—In spite of the smallness of the staff very good work is being done in the optical workshop, where much apparatus has to be constructed for the accurate determination of constants, such as the dispersion of various glasses, to the seventh decimal. The demands for flat work of all descriptions and sizes in various glasses, quartz, silica, rustless steel, speculum metal, soft transparent crystals, come from outside, as well as from the other departments of the Laboratory and the Admiralty Laboratory. The high accuracy necessary for this work has necessitated the conversion of one of the rooms on the ground floor into a constant-temperature room in which a temperature constancy within 1/20 deg. C. has to be maintainable for weeks. It is a room within a room, with double floor, ceiling and walls, entered by an air lock with heavy doors; the walls consist of wood and granulated cork, and the air is supplied and withdrawn through two trunks, one near the floor, the other near the ceiling, provided with many openings.

*Electricity Department. Electrical Standards and Measurements. Radiotelegraphy.* (Messrs. D. Dye, R. L. Smith-Rose, J. Hollingsworth, L. Hartshorn, C. E. Webb, F. M. Colebrook, H. A. Thomas.)—

*International Units and Standards.* (*Mr. Dye*).—In the exchange of pairs of the 1 ohm coils of the Laboratory with Paris, Washington and Japan some coils either suffered in transit or did not keep constant. A Russian standard coil brought to Teddington by Professor Issakoff has subsequently been remeasured

in Paris and Berlin; at present the value of the international ohm standard appears uncertain by 2 parts in 100,000. The exchanged manganin coils not having proved sufficiently constant, new mercury standards will have to be set up. As regards the Weston normal cells, Teddington and Washington agree within 1 part in 100,000. The mutual inductance standards of the Laboratory and of Japan (made to the design of the Laboratory and with its assistance) also agree within 1 in 100,000, both with the calculated values and with one another.

*Radio-Standards.*—The radio-standards of frequency incorporating the Bloch multivibrator have proved so satisfactory that a second multivibrator with a fundamental of 20,000 cycles per second has been set up, the whole range of wave-lengths now covered by these two vibrators being from 50,000 m. to 100 m. In order to avoid having to work with such high-order harmonics as the 150th, another vibrator is to be set up extending the range of standard frequencies up to $10^7$ per second.

The phonic wheel of the Eccles type which is used for the determination of the frequency of the tuning fork is valve-driven and has an additional driving magnet. To synchronise the wheel it is first run up to speed while controlling its own power; when the speed slightly exceeds that of the tuning fork, the fork-power amplified by a valve is gradually applied to the additional magnet; the wheel then quickly pulls into synchronism—as Mr. Dye demonstrated on the inspection day—the driving power may then be cut off again, when the wheel runs as a synchronous motor. The tuning fork frequency can be maintained to one part in 100,000. The multivibrator and instruments are very suitable for the calibration of wave-meters. A 2,000-volt generator has been installed for feeding the valves, and the outfit is to be used also for magnetic tests of materials at high frequency and high induction, a field in which much remains to be done. A search is further being made for improved materials for the Flinders bars and corrector balls of ship magnets; the time data will be collected on board.

*Dielectrics.* (Messrs. Dye and Hartshorn.)—The air-gap method mentioned last year (ENGINEERING, August 4, 1922, page 134) of determining the permittivity (dielectric constant) and power factor of sheet materials like mica by inserting them in an air-gap of known width is unsafe with materials of uncertain thickness, especially when they contain local conducting parts. When actual contact between the material and the electrodes can be secured more efficiently than by applying tin-foil to the mica, the measurements become more simple, and this contact is now obtained with the aid of a mercury electrode cell. The sheet to be tested is clamped vertically between the two halves of a circular cast-iron cell, 8 cm. in diameter, 5 mm. internal width, which is filled with mercury, the mercury entering slowly from below so as to avoid air bubbles; quartz washers are used in fixing the specimen between the halves of the cell.

*Intensity of Radio-Signals.*—The method by which Messrs. Hollingworth and Thomas measure the intensity of signals received from distant stations (including Rome and Lafayette, near Bordeaux) differs from the usual method in so far as they use a galvanometer instead of a telephone; the former is more sensitive (though fortunately not to the presence of the observer) and requires less time, because accurate tuning and screening are not required; this is important, when the signals only last a few minutes. The method of determining the amplification ratio of commercial valves is due to the same workers. Mr. Colebrook's thermocouples for such measurements were mentioned last year, as well as the F. E. Smith method and apparatus, by means of which Mr. Smith-Rose determines the amplification of low-frequency (audible) sound amplifiers.

*Radio-Direction Finding.*—We have on other occasions referred to the experiments arranged by Mr. Smith-Rose for investigating the errors, fixed and variable, to which radio-direction finders are subject. So far as possible simultaneous observations are taken at 12 Universities of the kingdom and at the Laboratory, also at 40 miles out at sea, with identical Robinson apparatus, of the apparent directions in which signals are received from various stations, using damped or undamped wave-lengths ranging from 2 km. to 9 km. The mean wireless bearing of a transmitting station, inland or abroad, over a prolonged period, it is found, may be in error by more than 20 per cent., owing to distortion of the incoming waves by obstacles such as buildings, trees, overhead wires, water pipes or streaks of metal; near Aberdeen such a disturbance was finally traced down to a brick sewer laid with a foundation of expanded metal, 6 ft. wide by 300 ft. long, 8 ft. below ground level. This "permanent" error is further subject to daily variations, amounting to not more than 2 deg. or 3 deg. in day time, but to as much as 60 deg. at night time. These variations are of about the same order all over the country, though certain stations have their peculiarities; they seem to have nothing to do with the weather or thunderstorms, and they are evidently of a complex character.

*Radio-Transmitting Station.*—The new transmitting station of the Laboratory consists of a hut, fitted with sets for generating both damped and undamped waves, an aerial, 450 ft. long, on masts of 100 ft. height and a counterpoise earth screen stretched on porcelain insulators carried by poles, 10 ft. high. The screen is formed by six parallel wires, each 600 ft. long, 20 ft. apart, and cross-wires, in other words, a rectangular network of wires in a plane of 600 ft. by 100 ft., 10 ft. above the ground. The transmission range will, with currents of 5 amperes, be about 150 miles; different conformations of the aerial are among the problems to be investigated.

*(To be continued.)*

# LITERATURE.

*A Dictionary of Applied Physics.* Edited by Sir RICHARD GLAZEBROOK, K.C.B., F.R.S. In five volumes. Vol. IV. *Light, Sound, Radiology.* London: Macmillan and Co., Limited. [Price 63*s.* net.]

WITH commendable promptitude, another, the fourth volume of the Dictionary of Applied Physics, has appeared, sustaining the interest and removing many of the apparent blemishes that impatience was inclined to attribute to imperfections in the original design, necessarily complex from the extent of ground covered. Perhaps with the appearance of the last volume, the editor will provide some additional explanation of the method of reference and of the reason for its adoption. The general plan of arrangement which was evidently thought out with deliberation, either requires an index or it does not. If an index is supplied it would seem to make the references superfluous, if there is none, the plan is inadequate and disappointing to those who consult the work. Suppose one wanted to trace the steps of the process by which the diameter of stars has been measured, he would select this volume in which the theory of light occupies a prominent place, and in which interferometers, Michelson's among them, fringe systems, and similar phenomena are described with minuteness, as the most likely, to contain the required information. Yet the present writer has not been able to find any reference to this example of successful work at Mount Wilson. Since Dr. I. A. Anderson, whose brilliant work on the measurement of star discs is well known, has supplied the article on the ruling of diffraction gratings, it is much more probable that the failure to find such reference is due to clumsiness and imperfect acquaintance with the system, than that it has been omitted.

With the varied contents of the volume, we imagine that the same unanimity of approval which has welcomed the previous volumes will be extended to this in even a more marked degree. It would be strange if it were not so, since some 40 contributors, many of them the great architects of the modern scientific world, who have identified themselves with particular inquiries, enriching science by their work and industry by its application, give freely of their experience to make the road of progress easy and attractive for others to follow. Moreover, many of the subjects treated are of comparatively recent development, giving wider aspects to received truths and providing illumination in unexpected directions. The discoveries of the laboratory are more in evidence than the applications in the workshops, though, of course, the connection between the physicist and the engineer must be of the closest, for the world suffers when the engineer fails to open up the new paths for human progress that the physicist indicates. One of the most patent services these volumes have rendered is to demonstrate the intimacy of these relations.

There are more than 70 articles in this volume, and therefore it is impossible to give any adequate summary of even the more important among them, if one were bold enough to decide what is important and what is not. Some of these articles are models of compression, and all must be supposed to show what the authors consider the cardinal features in the particular subject under treatment, viewed from the standpoint of applied physics. This term has no narrow significance. It does not suggest simply applications to technology or engineering practice, but rather an inquiry into a knowledge of the processes by which observed phenomena are produced, exhibiting the tools, or instruments, a physicist has at his command, either to explain past results or to develop the resources of the world to the best advantage; perhaps, too, indicating his limitations, though how far these are occasioned by present ignorance and therefore capable of removal it may not be possible to decide. On any narrower footing it would be difficult to explain, or defend, the presence of articles such as the one on "Crystallography," by Professor A. E. H. Tutton, or the discussion of the quantum theory by Mr. C. G. Darwin, to take haphazard examples. The facts established by the former and the possibilities they suggest in the future are of immense importance to the proper understanding of the inexorable laws of physics, whose sway is inevitable, while from the second example, we may learn the tentative and progressive manner by which hypothesis assume definite form. Certain phenomena have to be explained, and Planck's theory, illuminating and satisfactory up to a certain point, can be accepted, though it prove a partial view of a more general truth. By challenging inquiry it offers the means of penetrating further into the construction of the mechanism of the universe, though later it may be discarded for a more efficient instrument.

If in such instances the connection with applied physics is remote and forced, the balance is restored by the introduction of such technical matters as the manufacture of glass, to which subject Mr. E. A. Coad-Pryor does justice by presenting a mass of carefully considered detail, while able colleagues discuss the enhanced value bestowed on it by its colouration and ornament. To the construction, testing, and varied uses of lenses and prisms in the analysis of light, many authors contribute useful information, among whom may be mentioned Miss A. Barbara Dale, the only lady contributor to the volume, who writes on "The Testing of Simple Lenses and on Polarised Light." The Astronomer Royal for Scotland describes the telescope, Professor Conrady the microscope, and Dr. I. S. Anderson the ultramicroscope. Mr. Gamble discusses the application to photography and Dr. French to the kinematograph. Dr. Merton adds an interesting article on "Modern Spectroscopy," while the subject of diffraction gratings, interferometers, &c., and the results that follow from the use of such apparatus, has been entrusted to Dr. I. Guild. This list might be materially protracted, for it will be noticed that no mention has been made of the subject of photometry, or of the construction and use of reflectors and of their employment in projection apparatus. It is rather incongruous to find a description of the theodolite and other measuring instruments used in geodesy included in this volume rather than in the section devoted to metrology.

Sound, the second main section of the present volume, by reason of its fewer applications occupies much less space than does the discussion of light in its various forms, and Dr. E. H. Barton practically covers the subject in one continuous article, in which are discussed pitch and frequency, propagation and velocity of sound waves. Sound producers, especially musical instruments, are treated with considerable fullness, the piano being the subject of a separate article by Dr. R. S. Clay. The telephone and microphone receive apparently scant notice, but these

may have been handled elsewhere, and among sound detectors, sirens and fog-horns are passed over with short notice, but are again mentioned among navigational instruments by Instructor-Commander Baker. An interesting, if short, article is contributed by Professor W. L. Bragg, on the novel subject of sound-ranging, or the location of a source of sound by measurements made on the sound wave spreading from a source, when the sound has a sharply-defined origin. It recalls the scientific activities of war time and the experiments that had to be made under strenuous conditions. If the observations were to be of use in locating an enemy's position, the time had to be recorded with an error of less than $\frac{1}{100}$ second. Measurements of distance had to be of corresponding accuracy, and though the solution of the problem from a physical point of view was quite satisfactory, much time was consumed in making the necessary preparations, involving rigorous topographical surveying of the district. Professor Bragg states that the information derived was of great value, and presumably justified the expenditure of time and labour.

The last section is that of Radiology, a term that, judging from Dr. Kaye's article, is limited to the nature and behaviour of X-rays, the wider word Radiation being used apparently for the more general manifestations of radiant energy which still baffle complete explanation. This latter subject is discussed by Mr. C. G. Darwin, while a valuable and exhaustive paper on the determination of the constants and verification of the laws is contributed by Dr. W. W. Coblentz, of the Bureau of Standards, U.S.A. Radioactivity and radium, described by Dr. E. A. Owen, form the subjects of interesting articles that will attract much attention as dealing with a comparatively new subject that has awakened public curiosity, but on that ground, these will be earliest superseded, as new workers collect new facts and more startling applications displace the old. Already in regarding future developments, Dr. Kaye is regretting the limitations to radiometallography prescribed by equipment and technique. He looks forward on the one hand to the use of much heavier X-ray outputs and higher voltages, and on the other to the employment of more sensitive screens and plates, in order to make the methods more commercially attractive. Improvements, however, may come to our aid, rather by fresh developments than from the reinforcement of old processes, for science generally advances by unexpected routes and under strange guises.

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*Fabrication de l'Acier au Four Martin.* By A. BARBEROT. Paris: Librairie J.-B. Bailliere et Fils, 19, Rue Hautefeuille. [Price 40 francs net.]

"THE Open-Hearth Steel Process" is the title of the sixteenth volume of a new encyclopædia on mining and metallurgy published in France. There are, in all, 43 volumes, and the fact that the well-known French metallurgist, M. Léon Guillet, is editing the series is, in itself, a recommendation.

As is usual in works of this type, the subject is divided into several sections, each complete in itself.

In the first section, viz., "Raw Materials," the author deals, in a general way, with the various grades of pig-iron and scrap used in the manufacture of open-hearth steel and goes into the question of refractories. All the well-known types of gas-producers are next fully described, and the writer completes the chapter by briefly alluding to the utilisation of mineral oil, natural gas and coal dust as fuels in various localities. This section, although necessarily of a descriptive nature, deals very completely with the whole question of fuel and is well illustrated.

The long chapter devoted to furnace construction, in all its aspects, needs no special comment; it is of the same high standard as the rest of the work. The author leaves nothing out and shows himself to be a good practical steel man as well as a scientific metallurgist.

Dealing with the reactions which take place within the furnace, the author sets out detailed time-tables of typical heats working various processes, giving the composition of all raw materials used and the analysis of samples of both metal and slag. These are well worthy of close study, great pains having evidently been taken to make them complete. We regret having to record that, in one case, that of a 30-ton basic heat, there are several discrepancies between figures quoted in a table and those given in the text.

Tapping operations, ladles, ingot-moulds and the production of sound ingots, lifting gear, charging apparatus, and the general planning-out of an open-hearth steel department are all subjects treated in a thoroughly workmanlike way.

Lastly, the author discusses the commercial point of view and goes into costs, having in view the reduction of overhead and other charges to a minimum.

It is evident that M. Barberot has devoted a great deal of time and thought to the preparation of this treatise, and we heartily congratulate him on his successful achievement. Probably owing to the fact that, like many educated Frenchmen, he is a good German scholar, but is little acquainted with English, we find that whereas he has consulted *Stahl und Eisen* no less than 46 times, he has only consulted the Journal of the Iron and Steel Institute three times. Again, we find no mention of the works of such eminent steel-metallurgists as Riley, Harbord and Howe. No alphabetical index is given, and this, although practically an invariable rule in French bibliography, is unfortunate in the case of an encyclopædic work containing over 500 pages.

We should like to add, in conclusion, that M. Barberot, who is now director of the Saint-Dizier Works, was largely responsible for the erection, during the war, of the most extensive open-hearth steel plant in France.

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*Canada. Department of the Interior. Dominion Water Power Branch.* Water Resources Paper No. 33. *Central Electric Stations in Canada.* Part II. *Directory (November 1, 1922).* Prepared under the direction of J. T. JOHNSTON, C.E. Ottawa: J. B. Challis, Director of Water Power.

*United States Coast and Geodetic Survey.* Special Publication No. 93. *Reconnaissance and Signal Building.* By JASPER S. BILBY. Washington: Government Printing Office. [Price 30 cents.]

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*The Railways of Spain.* By GEORGE L. BOAG. London: *The Railway Gazette.* [Price 12*s.* net.]

*Grundzüge der Starkstromtechnik fur Unterricht und Praxis.* By Dr. Ing. K. HOERNER. Berlin: Julius Springer. [Price 4*s.* 2*d.*]

*United States Bureau of Mines.* Bulletin No. 211. *The Chloride Volatilisation Process of Ore Treatment.* By THOS. VARLEY and others. [Price 20 cents.] No. 216. *Bibliography of Petroleum and Allied Substances in 1919 and 1920.* By E. H. BURROUGHS. [Price 40 cents.] No. 217. *Preparation, Transportation and Combustion of Powdered Coal.* By JOHN BLIZARD. [Price 50 cents.] Technical Paper No. 300. *The Universal and the Fireman's Gas Masks.* By S. H. KATZ and others. No. 331. *Metal Mine Accidents in the United States during the Calendar Year 1921.* By W. W. ADAMS. [Price 10 cents.] Washington: Government Printing Office.

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*Modern Gas Producers.* By N. E. RAMBUSH, M.I.Chem.E. London: Benn Brothers, Limited. [Price 55*s.* net.]

*Radio, Telegraphic, Téléphonie, Concert.* By E. RAYNAUD-BONIN. Paris: Gauthier-Villars and Cie. [Price 10 francs.]

*Der Auf bau des Mörtels im Beton.* By OTTO GRAF. Berlin: Julius Springer. [Price 2*s.* 6*d.*]

## THE CABLE-LAYING STEAMER "FARADAY."

"FARADAY" is an honoured word in the submarine cable world, and the old ship of that name was probably better known to the general public than any other cable-laying steamer. She was familiar on the lower reaches of the Thames, her two funnels, arranged side by side, giving her a distinctive appearance easily remembered. The old Faraday was launched forty-nine years ago, in 1874, and since that time has laid and repaired cables in practically every part of the world. Her owners, Messrs. Siemens Brothers and Co., Limited, of Woolwich, have now replaced her by a new Faraday, which was launched on February 16 last and will leave London for her first voyage in the early days of August. The new Faraday is a vessel 380 ft. between perpendiculars, and with a beam of 48 ft. 3 in. and a draught of 27 ft. 3 in. Her length over bow and stern sheaves is 415 ft. and her gross tonnage is 5,530. Her net tonnage is 2,636. She is fitted with twin-screw sets of triple expansion engines, each with three cranks placed at equal angles. The cylinders are 21 in., 34 in. and 57 in. in diameter, and the stroke is 39 in. The engines will develop 2,960 i.h.p. when running at 88 r.p.m., and the valve gear is arranged so that the engines may, when necessary, conveniently be run at very low revolutions so as to drive the vessel at as slow a speed as three-quarters of a knot. The normal speed is 12 knots. There are three single-ended cylindrical boilers, 15 ft. 3 in. in diameter and 11 ft. 3 in. long, each having three furnaces with Howden's system of forced draught. The boilers are arranged for burning oil fuel exclusively and the oil fuel capacity of the tanks is 1,500 tons, giving the ship a steaming radius of 10,000 miles. The vessel has been designed to carry about 4,500 tons of cable and her water ballast capacity is 2,200 tons. She was built by Messrs. Palmers' Shipbuilding and Iron Company, Limited, at Jarrow-on-Tyne, and is classed 100 A.1 at Lloyd's.

The Faraday, when she leaves the Thames in a few days, will carry 1,000 miles of submarine telegraph cable, which she will lay from New York to Fox Bay, Nova Scotia. This cable has been made by Messrs. Siemens for the Commercial Cable Company, and is of a specially heavy type designed by the Cable Company's engineers for fast working. It is insulated with gutta-percha and the weight of the copper conductor is 450 lb. to the nautical mile. The armouring is of eight different types, this construction being rendered necessary by the varying depths of water between the points to be connected. It will be generally known that submarine cable has to be more heavily armoured in the shallower waters and at the shore ends. In this particular case the armouring has required special consideration owing to the fact that a large portion of the route lies across fishing grounds where the cable is likely to be disturbed by the anchors of ships.

The Faraday is built with four cable tanks, three being some 40 ft. in diameter and the fourth, forward, one somewhat smaller. Each tank has a watertight steel central cone built into the structure of the ship and around which the cable is coiled. These tanks have circular hatches, two of which can be seen in Fig. 1 (page 124)—a view of the shelter deck of the ship. As the cable is loaded on board it passes down the hatch over a guide pulley and is coiled by hand by a number of men who arrange it neatly so that the maximum possible length of cable is stowed in the available space. The various layers of cable are coated with whitewash to prevent any sticking together. With the cable carefully stowed in this way it is not necessary to have anyone in the tanks or to attend to the cable in any way during discharging when it is being laid. It runs off quite easily, the central cone serving as a guide and preventing any possibility of fouling. The tanks and cones are made with smooth surfaces, all rivets being flush, so that there are no points on which the cable can catch. Water of a sufficient depth to cover the coils of cable is carried in the tanks, gutta-percha retaining its properties much better when immersed in water. Special sumps and a water service independent of the bilge connections are arranged for this water supply.

The ship has a clipper bow which carries three cable sheaves and a cruiser stern with two cable sheaves fitted on the starboard side. Cable is laid from the stern with the boat travelling ahead. The cable from the tank is threaded through a swivelling guide carried at one side of the hatchway and passes along wooden troughs, as shown in Fig. 1, to the paying-out machine. This machine, which is illustrated in Fig. 2, is a type of steam winch and lifts the cable from the tank. A jockey pulley dynamometer arrangement indicates the tension on the cable. This is kept constant and calculated in terms of the depth of water in which the cable is being laid. The cable as it lies in the sea does not necessarily follow the absolute contour of the bottom and may simply span a local hole in the sea bed. If the paying-out dynamometer does not indicate any increase in tension the cable may safely be allowed

to span the gap. In the event of a large hole being encountered, however, so that a long length of the cable "floats," the tension will increase and the rate of paying-out must then be increased, or the speed of the ship reduced. This cable-laying process is in essence very simple, but one may well believe that very much experience and judgment are necessary to carry it out successfully on the high seas and in all kinds of weather.

The sheaves at the bow of the boat are employed in connection with cable repairs and recovery. For this work a picking-up machine is used. Of these there are two. They are illustrated in Fig. 3. These may again be looked upon as powerful steam winches working in connection with dynamometers. The machines are fitted with three-cylinder three-crank engines, in order that they may give a steady pull. Heavy gearing is incorporated in the machines, so that a very powerful lift may be obtained. When searching for a broken cable or one that requires repair a grapnel is utilised connected to the picking-up machine. The boat steams across the track of the cable backwards and forwards until the grapnel hooks on to the cable. The fact that the cable has been caught is indicated by the dynamometer. The ship is then stopped and the cable hauled in and secured by clamps at the bow. It will be obvious that not only judgment and experience but also luck enters into this picking-up work, and the finding of a cable may at times prove a very weary piece of work. There is, of course, also the chance that the grapnel may catch on a rock or some piece of material other than the cable being looked for, and that both time and tackle may be lost.

Any proceedings which take place with a cable which has been picked up will naturally depend on what it has been picked up for. In case a damaged part has to be renewed, however, the picked-up cable will be cut and the ends brought in-board, proper clamping arrangements naturally being made so that one or both of the ends may not be lost. Frequently one end only will be dealt with in this way and the other end will be buoyed so that it can be found later when required. The end of a cut cable may be run on board the ship by the picking-up machine. Repairs to cables or to joining in of a new length are carried out on the shelter deck of the ship and practically entirely by hand. After the connection of the core has been made and the gutta-percha insulation made good, the armouring connection in which practically the whole strength of the jointed cable lies is made entirely by splicing by hand. A very long splice is made and naturally great skill and experience are required for the work.

We had an opportunity of inspecting the Faraday last Monday as she lay at Woolwich taking in the New York-Fox Bay cable from Messrs. Siemens' works. The cable was run on board by electric winches temporarily fixed on the ship and passed over a guide pulley fixed on a barge as the ship lay some little distance from the wharf. The completed cable in the works is stored in circular tanks much of the same class as those on the boat. Water services are fitted, and water is run into the tanks to cover the cable so that it is stored under water. There are a large number of these tanks in Messrs. Siemens' works, and as they are built close to the wharf the cable can be run easily and quickly out of a works tank into a steamer tank. A luncheon was held on board the steamer in the attractive dining saloon at which Sir William Bull, as director of Messrs. Siemens, presided, and we have to thank Sir William, Captain Gange, the commander, and Mr. A. J. Stopher, who is in charge of the cable-laying operations, as well as various other officials of Messrs. Siemens, for showing us over the boat, as well as expressing our appreciation of the courtesy of the firm in giving us the opportunity of inspecting this very interesting vessel.

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REINFORCED CONCRETE BRIDGE OVER THE RIVER VESUBIE: ERRATUM.—By an unfortunate omission the dimension, in Fig. 1, Plate V, of our issue last week illustrating the new reinforced concrete bridge over the River Vesubie, showing the rise of the bridge, was given as 9 ft. 6 in. instead of 49 ft. 6 in.

SOUTHERN RAILWAY ELECTRIFICATION.—The Board of the South Eastern and Chatham Construction and Power Company, Limited, have intimated to the English Electric Company, Limited, Queen's House, Kingsway, and the Metropolitan-Vickers Electrical Company, Limited, Trafford Park, Manchester, that their two tenders for motors and control gear respectively have been accepted. These equipments are for the electrification of the first section of the South Eastern and Chatham division of the Southern Railway, and will cover the conversion to electrical operation of the suburban services within a 15-mile radius of Charing Cross. The equipments consist of 508 traction motors each of 300 h.p. with the appropriate controlling apparatus. The work will give employment to many thousands of people over a period of nearly two years; it forms part of an expenditure of 5,500,000*l.* which was the subject of a guarantee under the Trade Facilities Act.

# THE CABLE-LAYING STEAMER "FARADAY."

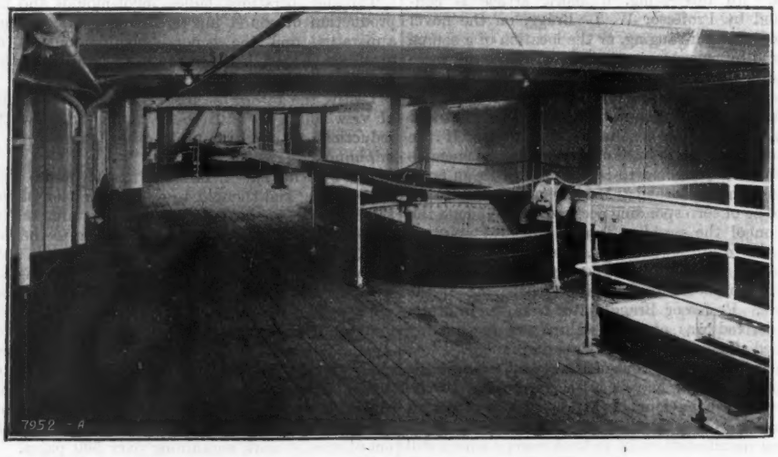



FIG. 1. SHELTER DECK, SHOWING CABLE TROUGHING.

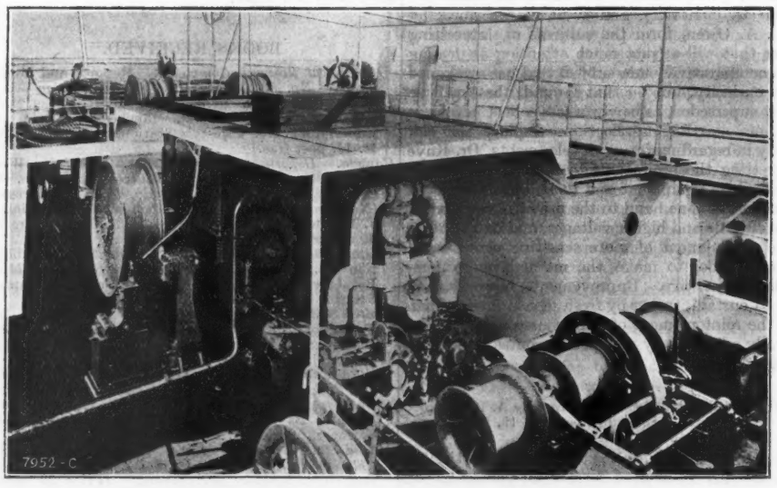



FIG. 2. THE PAYING-OUT MACHINE.

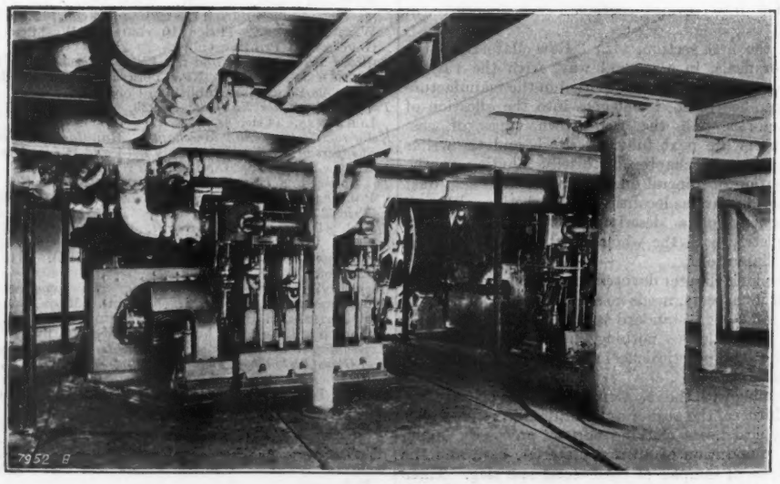
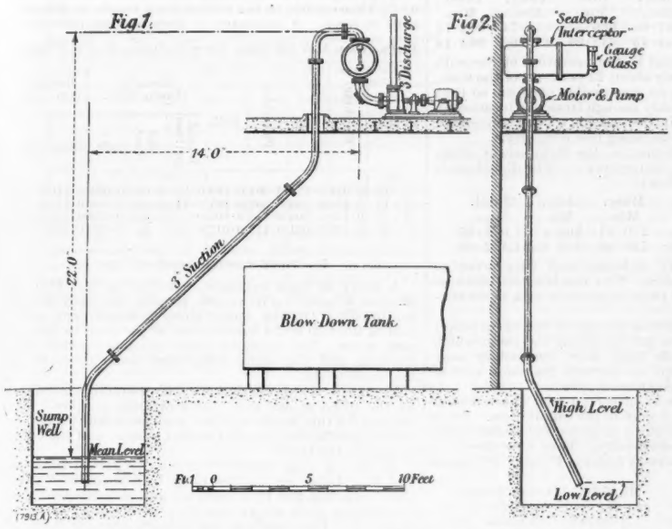


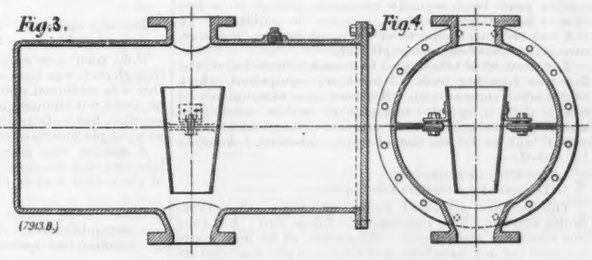

FIG. 3. THE PICKING-UP MACHINES.

# THE SEABORNE INTERCEPTOR.










ALL engineers who have had experience with centrifugal pumps which are situated much above the level of the water they have to lift, are only too well aware of the difficulties which often occur in starting. Water will have leaked away through the foot valve and left the casing full of air, which has either to be displaced by priming water or extracted by an ejector before the pump can be got to work at all. Whenever possible, of course, centrifugal pumps should work "drowned," but there are many cases in which this cannot be arranged, and under such circumstances the Seaborne interceptor, which we illustrate in Figs. 1 to 4, on this page, is likely to prove a most useful piece of apparatus. It enables a centrifugal, or other pump, to be started at once without preliminary priming or other attention, no matter how great the suction lift may be within reasonable limits, so long as the suction pipe is airtight. It is moreover free from any moving parts and of such extreme simplicity that it does not appear to contain any possibility of trouble.

Essentially the Seaborne interceptor consists of a closed vessel of cast-iron or steel plate placed on the suction line of the pump and at a somewhat higher level than the latter. The inlet to the interceptor is at the top, and the outlet to the pump is directly beneath it. Between the two is fixed a conical pipe as shown in Figs. 3 and 4. The position of the interceptor relatively to the pump is shown in Figs. 1 and 2. The action is as follows: When starting up, the upper end of the discharge pipe and the whole of the suction pipe may be filled with air, the only water in the system being that in the pump and interceptor casing which, together with a short length of the discharge pipe, form a kind of "trap." When the pump is started it takes water from the interceptor, lowering the water level in the latter and creating a partial vacuum in the suction pipe. This, of course, causes water to rise in the suction pipe, and the interceptor is so proportioned that water will start flowing into it at the top before it has been emptied by the pump. The interceptor will at this time be nearly full of the air which was in the suction pipe.

The incoming water passes down to the outlet through the short conical pipe, and in so doing acts as an ejector, taking with it some of the air through which it passes before entering the cone. In a short time practically the whole of the air which was originally in the suction pipe will have been carried through the pump by this means, and the interceptor will be very nearly full of water. This is the normal state of affairs when running. When the pump is stopped the water will run back through it until the level in the discharge pipe has fallen to that of the top of the interceptor. The remaining air in the latter is sufficient to prevent any siphoning action, so that the vacuum is broken and the suction pipe empties itself, leaving the pump and interceptor both full of water. The pump can then be restarted at any moment, the interceptor acting in the manner already described.

The arrangement shown in Figs. 1 and 2 represents an actual installation of the interceptor in one of the London power stations. It will be noticed that there is a vertical suction lift of 22 ft. to be overcome, and that no foot valve of any kind is fitted. The duty of the pump is to empty a dirty water sump at frequent intervals, discharging the water into an overhead tank. We have been given the opportunity of noting the behaviour of the interceptor in actual work, and in every instance starting was effected as readily as if the pump had been drowned. A gauge glass fitted to the interceptor casing enabled the action to be watched. In addition to its primary function of facilitating the starting of pumps, it is clear that the interceptor can also embody a strainer to prevent injurious materials from causing damage to the pump. The makers of the device are the Seaborne Interceptor and Engineering Company, Limited, of 45, Chancery-lane, London, W.C. 2.

## STEEL MILL PRACTICE.

*The Standardisation of Steel Mill Practice Through Time Study.**

By ROBERT GREGG, President, Atlantic Steel Company, Atlanta, Georgia.

IN a general sense, time study is so well known that it has come to be a household word in industry. When we limit it to the steel industry, however, we run into many complications and differences, so great that it amounts almost to a separate science. The peculiar problems and broader requirements make it a higher type of engineering here than in any other industry. For example, let us consider the stereotyped method of time study, which consists of timing a unit operation, calculating the number of such per hour, ignoring unnecessary delays, and setting up the resulting figure as a production standard.

In a steel mill this phase of the work is only incidental and is confined largely to the various finishing processes. Actual practice often shows itself inconsistent with the most carefully constructed theory, and the only remedy yet found is to make due allowance next time in our theory.

The reason? It may be the effect to a great amount of the human element; of the excessive heat; of large units introducing a greater probability of error; of the impossibility of minute control in chemical processes; or, most likely, a combination of these and other factors. Certain it is, however, that time study finds itself confronted with many problems which demand for their solution the services of men who know little about stop watches and a great deal about steel.

The result of the first efforts made to introduce this work into our plant clearly illustrates this point. We employed a firm of the highest rank among industrial engineers in the country, who installed a system which we still use altogether. But the system is all they furnished, for they knew their own profession and not steel. Their results were quite good where they involved only small units and finishing processes, these being the kind of material with which they were familiar; but wherever their work involved steel proper, it was worse than useless, for it made the science of time study an object of ridicule from which it has taken many years to recover.

In attempting to overcome this distrust and to establish the principles involved, a class-room course in personal efficiency was instituted, the results of which were highly beneficial. First starting with some 12 major supervising men, it later took in all foremen and subforemen, requiring daily classes of 1 hour duration each, whereby the classes were made sufficiently small to be conveniently handled. In a few weeks this resulted in an entirely different mental attitude towards the work of the time study department and really created a desire for the active assistance of the men in this department by the various operating superintendents.

There is no department in our plant which has not lent itself to this means of standardisation. When account is taken of the fact that the work overlaps not only to the operating end, but to every other staff department (accounting, designing, testing, &c.), it may be seen that our claim of a very high-class of engineering is not extravagant.

*Purposes of Time Study.*—Time study has two aims. The first is arriving at satisfactory standards; the second, offering suggestions for improvement.

By satisfactory standards is meant, primarily, production standards. It is our aim to know exactly what is the maximum capacity of every unit, and more especially to know what is the reasonably attainable output which can be expected day after day barring undue mishaps. These standards may be determined with more or less accuracy by watching the performance of fairly good equipment handled by fairly good men. Under these ideal conditions, our results would be fairly dependable; under other conditions, they would be worthless.

The standards set by intelligent time study are absolutely accurate. If at some future time any wide variation between actual and standard production is observed, we may feel sure that conditions have changed. Such variation would be an effective warning to us to determine what these conditions are: If better, to keep them so; if worse, to change them back to those which formerly obtained. In standardising production, we must necessarily standardise the equipment responsible. By this is not meant the installation of labour-saving devices, but rather the utilisation to the very best possible advantage of the equipment we have already. For example, the recommendation of a car-dumping system is not a part of our task, though the equipment of a machine with a simple guide to facilitate feeding, or the use of a better grade of steel in wearing parts, or the recommendation of an automatic stop for saving time, occupies a very important place. In other words, the expected return must be much greater than the outlay for any expenditure of money to deserve a place in recommendations based on time study.

In the same manner, the standardisation of production involves the standardisation of *personnel*, and this phase shares equally with equipment in the attention of the time study man.

The second aim mentioned for time study, that of offering suggestions for improvement in practice, seems at first glance a rather bold statement. When a comparatively green man sets out (and in such a highly technical industry) to offer suggestions to men who have spent their lives in the work, it necessarily brings forth some scepticism and occasionally hostility, the combating of which demands a prodigious amount of tact. Nevertheless, many suggestions of real value are received in this way. Very recently such a thing happened in a mill which uses a great many finely made dies. Until recently these dies were bought outside. Then for some reason it became impossible to obtain any more and we were forced to start making our own, whereupon all the trouble began. Production dropped far below standard, and men and management became dissatisfied. The mill *personnel* admitted themselves baffled. One of our time study men managed to get hold of a piece of the defective work along with the die which made it, and by close examination and comparison with a standard die, the trouble was located and is now being remedied.

But perhaps of even greater importance than original suggestions are those ideas gleaned from the men who actually do the work. These are the ones who know most minutely and forcibly the details that need correction. They have the advantage of being in constant and intimate contact with their jobs, but lack the education, the freedom, the perspective, or the expression to change what they know to be wrong. The management, on the other hand, has most that the workman lacks, but due to this very fact it cannot stay in very close touch with details. The time-study man fills the well-defined gap between these two. He stays in as close contact with the work as do the workers themselves. He makes friends with them, spending an hour, if necessary, in talking about the weather in order to coax them to talk about their jobs. He must sort out the good ideas from the bad, and then present them (always giving due credit) to the management as concisely and forcibly as possible.

In addition, both management and men labour under one disadvantage which does not trouble the time-study man. This is that they are accustomed to seeing things as they are and have been—a sort of mental inertia which is often the cause of enormous industrial crimes. The efficient time-study man goes on a job with the assumption that everything is wrong until proven right, being very careful, of course, not to let anyone else suspect his attitude. It is surprising, sometimes ridiculous, what malpractices have been discovered in this way.

We will now take up in detail some concrete examples of standardisation of practice through time study.

*Open-Hearth Department.*—This department is almost

* Paper read before the American Iron and Steel Institute, at New York, May 25, 1923.

entirely technical. Therefore, if any beneficial results can be obtained here, it is safe to say that the same should be possible in any branch of the steel industry. Such results have been actually obtained, though to a less extent here than elsewhere, it must be admitted. In the less technical aspects of the open-hearth, however, much more has been accomplished.

The method of attack was to keep a minute log of the furnaces together with all auxiliary equipment which might affect their output. By this means were uncovered many delays, mostly mechanical, which were then analysed and traced to their sources. The greatest delay was found to be on the charging machine. Analysis indicated :—

1. Insufficient inspection.
2. Design of controllers too flimsy.

The furnace *personnel* knew, of course, that these faults existed. The management knew also ; but they did not have the specific information as to how many minutes per day were lost, and what was the exact nature of the trouble.

There are regular channels for the correction of mechanical defects, but, due to the mental inertia referred to above, such channels are not always utilised to the best advantage.

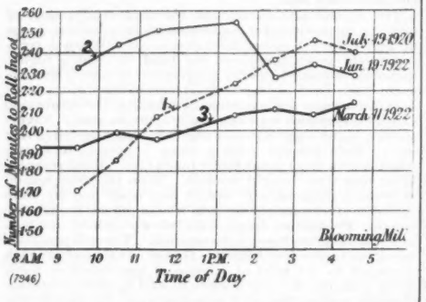
A very striking example was found in a controller on a hoist in this department. The arm would travel too far and the contact fingers would catch behind the last segment, making it necessary to jerk out the switch quickly to avoid a serious collision. It would have required, perhaps, 10 minutes to correct it ; yet during our two months' study, and no one knows how long before, it had remained an element of delay and danger.

The following are some of the other faults which were brought to notice during the same study :—

1. Hydraulic equipment sluggish, due to clogged pipes and worn pistons.
2. Exposed hydraulic piping, often broken by falling scrap.
3. Leaks in building roof, directly over furnaces.
4. Scrap pans badly stocked.
5. Powdered coal burners too fragile and too hard to clean.
6. Various equipment, valves, ladle stands, motors, &c., insufficiently protected.

Steps were taken to correct all of these conditions in accordance with the recommendations. With the exception of a few which have since become obsolete, they are still in use. The needs were apparent to the most casual observer, and the methods of procedure were comparatively simple. The only explanation we can offer for such a state of affairs as existed is the inertia, as mentioned before, of *personnel* who had become accustomed to it.

*Blooming Mill.*—This department is less technical than the open-hearth, and the results of time study have been correspondingly more specific. The same sort of study was made on the rolls, and an enormous loss




appeared due to faulty heating. Curve 1, of the diagram above, shows what was happening. Early in the morning the steel was over heated and rolled very easily, quality being sacrificed thereby. During the course of the day, the steel became continually colder and the minutes per ingot rose rapidly.

The recommendations based on the study were :—

1. Equip all soaking pits with efficient air control.
2. Install water-cooled division walls.
3. Charge ingots differently so as to place 12 to 14 ingots in each pit, instead of 10.

These recommendations were all carried out and are now being used. In addition the mill management, surprised at the conditions shown in the study, began to take vigorous steps to improve general heating practice. The result is shown in curves 2 and 3. (The only quality of these curves to be considered here is their average slope. Their relative height depends on other conditions, some of which will be explained later.)

The study further showed that four men in the mill could be eliminated by combining jobs. The first set was the door-boy and the ingot car operator. Both of these were idle the greater part of the time, but the pit doors had to be closed at the same time that the ingot car started off.

The door-boy might be at any one of four places, while the car operator was always at one place. The suggestion involved the installation of four levers for the latter, all on the same shaft, but each beside one of the door controllers, by which arrangement it is a simple matter for one man to operate the two jobs simultaneously.

The second pair to be combined were the jobs of the ingot transfer operator and the soaking pit crane helper. Studies on these men gave the following results :—

| | Busy. Min. | Idle. Min. | Away. Min. | Total. Min. |
|---|---|---|---|---|
| Transfer operator | 187·60 | 669·41 | 18·71 | 875·72 |
| Crane helper ... | 213·43 | 613·09 | 136·62 | 963·14 |

Both men were essential to the operation of the mill, though each was busy only about 22 per cent. of the time. One was stationed upon an inaccessible platform so that he could not change quickly enough from one location to another, but a stairway in the position was recommended as a simple means of overcoming this difficulty.

A similar case was found in the flying-shear scrap labourer and the cooling bed operator. The distribution of their time was as follows :—

| | Busy. Min. | Idle. Min. | Total. Min. |
|---|---|---|---|
| Scrap labourer ... | 210·51 | 865·85 | 1,076·36 |
| Cooling bed operator | 719·48 | 452·61 | 1,172·09 |

Neither job was very arduous, and they were so disposed as not to conflict. This combination likewise involved the moving of three controllers to a more convenient location.

The fourth man eliminated was one of two extra pulpit men. This one had been put on during the boom which followed the war, while men were demanding easy jobs. He had been kept on through the same sort of inertia which has been mentioned before.

On one occasion, it was suspected that the mil ]was being retarded by a green man in the pulpit crew. Since there were three men working in pairs, no studies could be made on this man individually. They were therefore made on the various pairs as follows, C being the green man :—

| Crew. | Minutes per Ingot. | Bloom Turns in Rolls. |
|---|---|---|
| A and B ... ... | 2·25 | 3 times |
| B and C ... ... | 2·46 | 15 times |
| A and C ... ... | 2·43 | 10 times |

On the strength of this data, C was replaced by another man, D, with the following results :—

| Crew. | Minutes per Ingot. | Bloom Turns in Rolls. |
|---|---|---|
| A and B ... ... | 2·01 | 7 times |
| B and D ... ... | 1·98 | 5 times |
| A and D ... ... | 2·05 | 4 times |

The averages of these sets of data are the ones plotted in curves 2 and 3 of the diagram. The curves show a difference due to better condition of equipment, while the tables above give comparative results on *personnel*.

It may be mentioned in passing that this is the only occasion when a man was discharged on evidence gained from time study. There are times when it would be convenient to employ it thus, but the moral effect of a man's knowing that he is liable to be fired as soon as the study is over, we believe, would defeat to a large extent the purposes of the study as already outlined. We have therefore made it a fixed policy that no man is even to be reprimanded on information gained through studies on himself.

*Merchant Bar Warehouse.*—In this department the time element is not the first consideration. Of greater importance are space and accuracy, and it is to a large extent with these that most of our standardisation work has been concerned.

A great many complaints had been coming in due to errors in counting bars. On investigation, it was found that these bars were sheared in varying numbers per stroke and counted by labourers. The process therefore was entirely mental, and was done by men from whom no great accuracy could reasonably be expected. This condition was remedied, first, by standardising the number of bars to be sheared at a stroke, and second, by equipping the counters with proper registers. The process is thereby made almost entirely mechanical, and the accuracy has been correspondingly increased. A further refinement proposed in this connection is to mount the gauging table on hinges so that the bars can be dumped after each shear stroke. By attaching a register to the table, the human element will be practically eliminated and one labourer will then be able to operate the table, instead of two as at present. The scrap loss was found to be unnecessarily high, due to the following causes :—

1. Lack of proper planning of most economical combinations of bar to be cut from a given length.
2. Sluggish operation of cooling bed, due to defective lubrication.
3. Bar dumped from cooling bed at too high speed.
4. Large bar rolled from billets so small that the average length left over is too short to use.
5. Stock length for bar was not a multiple of the most popular lengths. That is, bar was sheared 55 ft. long for stock, whereas 20 ft. to 40 ft. were by far the most popular lengths. Forty feet was therefore recommended as the proper stock length.

In all the above cases, the bare fact of finding where the trouble lies is all the warehouse needs, and steps are now being taken to correct the faults. Bars were observed, sheared at a high temperature. The contraction in cooling amounted in some cases to 4 in.—a fact which surprised everyone.

The greatest problem in the warehouse was one of gaining sufficient space for the stock carried. The project of extending the building was under discussion, but we now believe that it will be unnecessary. Instead, a system of racks was designed, made of rails set upright in the floor. Each rack is wide enough for one bundle of stock and deep enough for 10 bundles. Previous to the study, bars had been piled not over four bundles deep, with rails between layers in order to slip chains through. The rails are unnecessary with the racks, because each bundle will have three slings of scrap steel cable left on it until finally used. This alone nearly doubles the storage capacity in addition to reducing the labour of hooking up bundles.

*Hoop Mills.*—An interesting state of affairs was shown up by time studies on the rolls and roll-hands on different sizes of hoop. A summary of these studies follows :—

10-*In. Hoop Mill* (*all Time Given in Decimals of a Minute*).

| Product | Finishing. | Roll. | Planishing. | Roll. | Rougher (Down Side). 1st and 2nd Pass | Rougher (Down Side). 3rd Pass. | Rougher (Down Side). Idle. | Rougher (Up Side). Busy. | Rougher (Up Side). Idle. |
|---|---|---|---|---|---|---|---|---|---|
| in. | | | | | | | | | |
| 1½×10 | 0·054 | 0·171 | 0·064 | 0·188 | 0·131 | 0·082 | 0·001 | 0·110 | 0·115 |
| 1½×17 | 0·138 | 0·140 | 0·102 | 0·161 | 0·143 | 0·088 | 0·038 | 0·116 | 0·148 |
| 1½×18 | 0·138 | 0·104 | 0·118 | 0·100 | 0·106 | 0·080 | 0·016 | 0·109 | 0·079 |
| 1 ×17 | 0·120 | 0·031 | 0·113 | 0·017 | 0·117 | R | 0·008 | 0·133 | 0·011 |

R—Repeater used to handle this pass.

A study of these averages revealed the fact that on all sizes of hoop the down-side rougher was busy almost continually. On the larger sizes, however, any other part of the mill could handle from 50 per cent. to 100 per cent. more. The examples given (up-side rougher, and finishing and planishing rolls) were those parts which had most to do.

From this it appears that the mill production is limited by the speed of one man, the down-side rougher. The remedy for this was to split his work between two hands, one to handle the first and second passes, and the other to handle the third.

An idea of what would occur may be gained from the last line, taken on smaller hoop. In this, the " third pass " was handled by a repeater, and an examination of the various parts shows that they were almost perfectly balanced. This condition was actually brought about on larger sizes by the means suggested. The billet heating furnace then became the pacemaker of the mill, which alone shows that the practice was improved.

*Results in Wire Departments.*—Our barbed wire mill is the most perfectly standardised department of our plant. So thoroughly have the various styles been studied that it is now possible to set accurate standards on any new style without taking further time studies. If it is found impossible to attain any standard, we would expect to find some condition wrong in the mill itself.

Our production department recently received a request from this mill to lower the standard on a certain style of wire, since they considered it unreasonably high. This standard had been in effect for six years, and we were unwilling to lower it without a very thorough investigation. It was developed that although the men were working consistently, the machine speed on this size was only 215 r.p.m., whereas our former studies showed 235 r.p.m. Tracing this to its source, it was found that a smaller pulley had been put on the motor for making war wire, and had since been forgotten. A larger pulley was substituted, and there has been no difficulty in making standard.

This is an excellent example of the value of standards in giving warning of the existence of improper conditions. There was no one in the entire plant who remembered this change, and had it not been for our previous studies and the standards, it is doubtful whether the pulley would ever have been replaced.

Next in completeness of its standardisation is our field fence mill. In 1916 it was thoroughly investigated by our production department, and standards set up for each style. For one particular style, a standard of 46 rolls per day was inaugurated and bonus payment started on that basis. In 1920 we suddenly awoke to the fact that our production on this style was averaging 30 rolls and the others were correspondingly low. The machine operators, naturally, were making practically no bonus. A series of studies was immediately begun, and showed a general average as follows (the results of two previous studies are given for the purpose of comparison) :—

| | 1920. Min. | 1920. Per Cent. | 1916. Min. | 1916. Per Cent. | 1914. Min. | 1914. Per Cent. |
|---|---|---|---|---|---|---|
| Operating delays | 1,588 | 11·6 | 472·15 | 11·5 | 2?1 | 10·1 |
| Die trouble .. | 2,603 | 19·0 | 343·10 | 11·3 | 678 | 31·8 |
| Mechanical delays | 2,150 | 15·7 | 322·87 | 10·6 | 175 | 8·0 |
| Inattention of help .. .. | 1,511 | 11·5 | 269·78 | 8·8 | 251 | 11·4 |
| Total delay .. | 7,852 | 57·3 | 1,407·90 | 46·2 | 1,326 | 60·5 |
| Total operating time .. .. | 5,837 | 42·7 | 1,640·94 | 53·8 | 868 | 39·5 |

From these results, it will be seen that the operation in 1920 was much less efficient than in 1916. It was also less efficient than in 1914 (before bonus was begun) since the item of die trouble had been so materially reduced by simplification of dies.

Further analysis of the 1920 results shows a decrease in operating delays, as is natural in view of the decrease in net operating time. All other delays had increased. The greatest increase was shown in the two classes due to the condition of the machines, namely, die and mechanical trouble. It was believed that practically the entire cause was to be found here, since with machines in such poor condition bonus incentive to the *personnel* was practically eliminated.

This state of affairs was remedied first by instituting a systematic campaign for putting all machinery in first-class condition. Next, the influence of the mill manage-

ment was brought to bear on the machine operators and helpers. These, as soon as they found that production and bonus were dependent upon their own effort, were not slow to respond, and it was not long before the mill was making standard.

*Results in Other Departments.*—Repair shops in general do not lend themselves very readily to standardisation of output, the reason being, of course, that a job may not recur once in a year or more. We have gained some satisfactory results, however, in standardisation of conditions, and it is these which will be discussed here.

The studies showed that our machine tools were cutting at from one-fourth to one-eighth of the Taylor rate. The reasons were :—

1. Lack of instructions.
2. Machines in too poor condition to stand fast cutting.
3. Tools improperly tempered, due to lack of heat-treating facilities.

To remedy the first, forms were drawn up to be used as instruction cards for all jobs. These have never been adopted, and we are not sure that they would prove practicable, on account of the wide diversity of work mentioned above. In any other place than a repair shop, it is certain that they would be helpful, and even here we believe the experiment would be worth trying.

For the second, we could only recommend that a number of machines be thoroughly overhauled, and this was done as soon as their condition was brought to the attention of the management.

The third condition is one which has been met with in every department of the plant. Tool steel is used everywhere, and the evidence of enormous losses due to haphazard methods of hardening has been consistent and conclusive. It is only recently that proper provision has been made to overcome this waste, but marked improvement is now evident.

Another cause of inefficiency in our machine shop was found to be the lack of proper small equipment and tools for the machines. There was recorded a delay of 2 hours and 5 minutes on a milling machine waiting for an arbour to be repaired. Another man spent 7 hours during a gear-cutting operation trying to adapt an arbour to cutters which it did not fit. Such a delay would be almost unbelievable if we did not have the stop-watch readings before us. The particular job may never be done again, but the general conditions revealed by the study have been invaluable.

There were several flaws discovered in our cost-keeping system during the same study. One of these was that it was not minute enough for certain purposes. As a result, we were making our own cold chisels at 1·73 dols. each, whereas they could be bought for 1·45 dols. A similar condition obtained in the case of sledges and other tools.

It was recommended that the cost of such articles be kept more accurately, that frequently comparison was to be made with current market prices and that we buy outside if we were not able to make them at least as cheaply.

Incidentally it was found that the cost of heating certain work in the forge shop was as great as the labour cost.

No individual charge was made for heating, however, so that our costing would show many articles to cost only half of the actual figure. To remedy this, it was recommended that our heating furnaces be charged to a job on a service card, the same as labour.

Another service department where considerable inefficiencies were uncovered was the yard. Table A gives a time study on a piece of its equipment, a heavy shear cutting scrap rail. The timing was done here without a stop watch, the unit of time being a shear stroke. The effective cutting strokes amounted to 29·05 per cent., all the others being lost. Some loss was unavoidable, particularly that occurring while disposing of the last end and pulling up a new rail. There was a great amount of unnecessary loss, however, due to lack of proper guards. The practice was to shove the rail into the jaws, jump out of the way, and then return and pick up the rail, which usually had fallen entirely off the feed rollers. A set of effective guards could easily have been devised and would have eliminated the delay of picking up, as well as reduced the element of danger. The losses due to lack of these guards alone were as follows :—

| | Per Cent. |
|---|---|
| Rails jump backward ... ... ... | 7·95 |
| Rails jump forward ... ... ... | 4·37 |
| Rails slide out of jaws ... ... ... | 5·11 |
| Rails caught on blade ... ... ... | 2·34 |
| | 19·77 |

This case illustrates one of the fine points of efficiency, namely, the possibility of producing more with the same effort. It can be readily seen that a great deal of additional rail could have been sheared with the effort uselessly expended in picking up that which had fallen away.

The last example we wish to present is one phase of our store room, namely, the casting yard. The time element likewise plays no part here, but the attempts at standardising material have proved so successful that they are worth outlining at some length.

Our stock of spare castings had grown, very much at random, from a few pieces to a matter of a half-million pounds. The methods of keeping track of them had not been correspondingly developed, so that we had a large quantity of material and no records of it beyond an approximation of the gross weight and what little the store-room *personnel* were able to remember.

Moreover, castings were ordered whenever needed by anyone of a dozen different authorities, most of whom had a liking for ordering in round numbers. That is, if one of these persons needed six pieces, he would order ten or a dozen. The surplus would go to the casting yard, where it might remain indefinitely or not, according to the nature of the job. On the other hand, there was no certainty that a vital part would always be found in stock, this depending on whether one of the dozen authorities had happened to foresee the need.

The yard itself was in bad shape, there being a great deal of used or obsolete stuff mixed in, with no means of separating it. Castings for the different departments were not kept separate, and many were piled on each other so badly that it was impossible to take a correct inventory. Our first step was to take an approximate inventory. From this, a plan was drawn up of the yard, and sufficient space allotted to each department for its stock. All scrap, obsolete, or second-hand material was moved out, and the rest rearranged in accordance with the plan. A vast amount of detailed work was necessary in making sure of the names and numbers of the various castings, but we persevered until our doubtful list contained only about 2 tons. Then, an accurate inventory was taken, and the results placed on standard store-room ledger sheets. Castings are now handled like all other material. It is possible at any time to know exactly what we have on hand, the name, number, material, &c., and all this is done with no more work than was necessary under the old system.

An incidental advantage gained from these records is our ability to catch stolen castings. What our loss from this source was before we cannot guess. But since we wish to emphasise the fact that no hardship is worked upon any department by this reduction, because more necessary castings are carried than before. The only ones that have been eliminated are those which are not particularly vital to continued operation, or which had been piled up in excessive amounts. The last figure is the weight towards which we are reducing, in other words, the standard. It may take many years to reach it, for of course we are not actually scrapping material which may some time be used, and some items had been piled up sufficient to last for twenty years. Nevertheless, this serves as an ideal, and its value is shown by the substantial reduction in the present tonnage over those preceding.

In summary, we may say that our standardisation work has paid back all that it cost plus a good profit. Not only has it paid, but it has done so under conditions about as adverse as could be imagined. One of these adverse conditions has already been discussed—the very exacting requirements of the steel industry.

Next in magnitude has been the attitude of many of our *personnel* in the past. It is only human for a man who has fought his way to a position of responsibility by hard work to resent any seeming interference with his authority. In the early days such opposition occurred often and violently. Gradually, as we were able to convince them that we intended no immediate harm, their attitude became one of passive acquiescence. This was as bad as the first, however, for any time-study work demands not only the assent, but the enthusiastic support of the line executives in order to be successful.

Just following the class-room work previously mentioned, we began to receive requests for the services of our time-study men, in many cases from those who were formerly the most rabid in their opposition. This we regard as a great moral victory for the work. No effort is spared to cultivate such a spirit among our operating departments, for it is the pivot upon which all our results must hinge.

There are other circumstances which have hindered us—the war and its "hang-the-expense" spirit, the subsequent depression with its lowering of the morale of line and staff alike, and many smaller disturbances. But on the whole, it has been worth while; and since we have no reason to expect any more such serious hindrances for some time to come, we are going to bend every effort toward bringing the work of standardisation to the highest possible degree of perfection.

TABLE A.—SHEARING SCRAP RAILS.

Analysis of number of shear strokes lost from various causes.

| Rails per Car. | Cutting Strokes. | Men Slow. | Rails Jump Back. | Rails Jump Forward. | Slide Forward Out of Jaws. | Jump Back Lengthwise. | Caught on Bottom Blade. | Fail to Cut Through. | Caught on Conveyor. | Throw Over Last End. | Pull Up New Rails. | Other Delays. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 49 | 164 | 27 | 46 | 4 | 18 | 8 | 4 | — | — | 65 | 310 | 99 |
| 24 | 161 | 27 | 41 | 24 | 50 | 16 | 7 | — | — | 29 | 137 | — |
| 21 | 170 | 14 | 42 | 69 | 12 | 20 | 5 | — | — | 25 | 89 | — |
| 26 | 160 | 22 | 57 | 32 | 48 | 3 | 7 | — | — | 25 | 193 | — |
| 26 | 197 | 13 | 44 | 51 | 2 | 0 | 14 | — | — | 26 | 43 | — |
| 23 | 165 | 5 | 39 | 22 | 4 | 7 | 8 | — | — | 27 | 66 | — |
| 60 | 228 | 25 | 67 | 11 | 15 | 7 | 26 | — | — | 69 | 126 | — |
| 37 | 101 | 4 | 41 | 32 | 39 | 43 | 9 | — | 2 | 63 | 232 | — |
| 22 | 168 | 16 | 45 | 24 | 27 | — | 8 | 5 | 12 | 34 | 261 | — |
| 22 | 126 | 2 | 38 | 16 | 57 | 10 | 10 | 14 | 34 | 26 | 147 | — |
| 21 | 117 | 2 | 35 | 3 | 6 | 8 | 19 | 24 | — | 25 | 247 | 33 |
| 20 | 113 | 5 | 24 | 16 | 10 | 8 | 18 | 63 | — | 26 | 194 | 47 |
| 22 | 169 | 34 | 32 | 14 | 1 | 17 | 28 | 2 | — | 31 | 260 | 3 |
| 30 | 157 | 31 | 48 | 18 | 25 | 17 | 17 | 10 | — | 44 | 250 | 3 |
| 23 | 124 | 8 | 36 | 13 | 94 | 26 | 7 | 31 | 48 | 35 | 124 | 5 |
| Total 426 | 2,320 | 235 | 635 | 349 | 408 | 190 | 187 | 149 | 96 | 550 | 2,679 | 190 |
| Per Cent. — | 29·05 | 2·94 | 7·95 | 4·37 | 5·11 | 2·38 | 2·34 | 1·87 | 1·18 | 6·89 | 33·54 | 2·38 |

Of the total number of strokes (7,988) the delays (5,668 strokes) amounted to 70·95 per cent.

In addition to this, there has been worked out a standard quantity of castings to be carried in stock at all times. Many which we have on hand have been eliminated entirely, it being assumed that these will be ordered in exact quantity as needed. The process of ordering is now very simple. "Stock castings" are ordered by the storekeeper as soon as the quantity on hand drops below a fixed quantity. Other castings can be ordered only for particular jobs, and in exact quantity needed.

The following figures will indicate what the tendency has been :—

| | Lb. |
|---|---|
| Weight of castings on hand, January 1, 1922 ... ... ... ... ... ... | 480,000 |
| Weight of castings on hand, January 1, 1923 ... ... ... ... ... ... | 390,000 |
| Weight of castings on hand, April 1, 1923 ... ... ... ... ... ... | 299,070 |
| Weight of castings on stock casting list | 105,600 |

RAILWAY ELECTRIFICATION IN NATAL.—According to *The South African Mining and Engineering Journal* the work of electrifying the Glencoe-Maritzburg section of the main Johannesburg-Durban line is actually now in progress. This section is 180 miles in length and it carries some of the heaviest traffic of any railway in South Africa. This is the first large railway electrical enterprise of the union.

NON-FERROUS METALLURGY IN SWEDEN.—In comparison with the iron industry, states *Swedish Export*, the other metal industries of Sweden at the present time hold a very subordinate position. During the last few years, however, there have been rapid changes, the main cause of which is to be found in the development of electrometallurgical processes for the treatment of certain metals. Owing to the abundant supply of cheap water-power there are good prospects of the future production of metal on a large scale in spite of the fact that the raw materials necessary for this purpose have largely to be imported from abroad. Even now there is a relatively large export of rolled, drawn and welded products of copper, brass and aluminium.

DEEPENING OF THE DROGDEN CHANNEL.—The much-discussed question of the deepening of the Drogden Channel, in the Sound, past Copenhagen, has now been decided, and the work is expected to commence at the end of July or the beginning of August. The distance is about 6 km., and the channel as regards the northern third of its length will be 250 m. wide, increasing in breadth until it is 380 m. at the south end; the depth will be 8·5 m., or in any case so much as to allow vessels of 7·7 m. draught to pass. The bottom of the channel is almost entirely covered with stones, the size of paving cobbles, below which are larger rocks which may give a little trouble. The spot is much exposed to wind and weather and no more than 200 working days a year can be reckoned upon. The work is to be finished by November, 1925.

THE ENGINEERING PROFESSION IN DENMARK.—The position of engineers in Denmark has become so difficult that the three unions of engineers in the country have published an earnest warning to young men to consider the matter very seriously before they choose engineering as a profession. A year ago a first warning was published and since then matters have become worse. A large number of diploma engineers are without employment, and many have had to accept very modest situations which do not justify or require the protracted and expensive education of an engineer. The general depression has affected engineers far more than most other professions. In Denmark engineering was a precarious profession before the war, but there were then opportunities of finding satisfactory employment abroad. This is extremely difficult at the present time. A considerable period is likely to elapse before matters become normal again, and for the next 10 years it is considered that Denmark's requirements in the way of engineers are likely to be fully met by the present students at the Polytechnic College in Copenhagen.

## CLYDE MARINE OIL ENGINES.*

By Professor A. L. MELLANBY, D.Sc., Member of Council.

EXAMPLES OF TWO-STROKE CYCLE ENGINES.

(*Concluded from page* 98.)

THERE is little doubt that the design of a successful two-stroke cycle engine presents many features of great difficulty, and it is interesting to note how these difficulties have stimulated the designers devoting themselves to the development of this class of prime mover. Examination of the various two-stroke cycle engines now in actual service will disclose the fact that there is more variety in the types made by different builders than there is between those made on the more conservative four-stroke cycle system. The different ways in which the difficulties encountered in the development of this engine have been overcome make a study of special interest. Probably the greatest problem of the two-stroke cycle engine is that associated with the rejection of heat through the piston, cylinder head and walls, and the successful elimination of the increased stresses that may arise from the necessity of this increased rate of heat transmission is a question upon which much care and thought has been expended.

*Camellaird-Fullagar Engines.*—Engines of this type are under construction by Messrs. John Brown and Co., Limited, and Messrs. David Rowan and Co., Limited. The first-named firm have now in their shops a six-cylinder engine, 22 in. diameter by 33 in. stroke, capable of developing 1,900 b.h.p. at 85 r.p.m., the first unit of a twin-screw installation. Messrs. Rowan are also occupied with a six-cylinder engine, 18½ in. diameter by 25 in. stroke, capable of developing 1,500 b.h.p. at 110 r.p.m. This engine is constructed upon what is known as the opposed-piston system, and is, in some respects, similar to the well-known Oechelhauser gas engine. There are, however, essential differences between the two engines, the nature of which may be realised from a study of Figs. 9 and 10, which show sectional views of the engine now being made by Messrs. David Rowan and Co. It will be seen that each unit consists of two side-by-side cylinders, and that with each cylinder there are associated two pistons and one crank. The cranks are set opposite to one another, and the bottom piston of each cylinder is attached to its appropriate crank through the usual crosshead and connecting rod. The particular feature of the system is, however, the connection of the top piston of the left hand to the bottom piston of the right-hand cylinder, and the top piston of the right hand to the bottom piston of the left-hand cylinder, by external oblique rods. In considering the action of the engine, it may be assumed that the pistons of the left-hand cylinder are at their position of closest approach, and that those in the other cylinder are each at the outer end of their stroke. Combustion takes place in the left-hand cylinder and the pistons are driven apart, the bottom one transmitting its load to the crank through the connecting rod. At the same time, the pistons in the right-hand cylinder are drawn towards each other by the oblique rods, so that two equal and opposite impulses are thus given to the line cranks. When near the ends of their strokes, each of the left-hand pistons uncovers a row of ports.

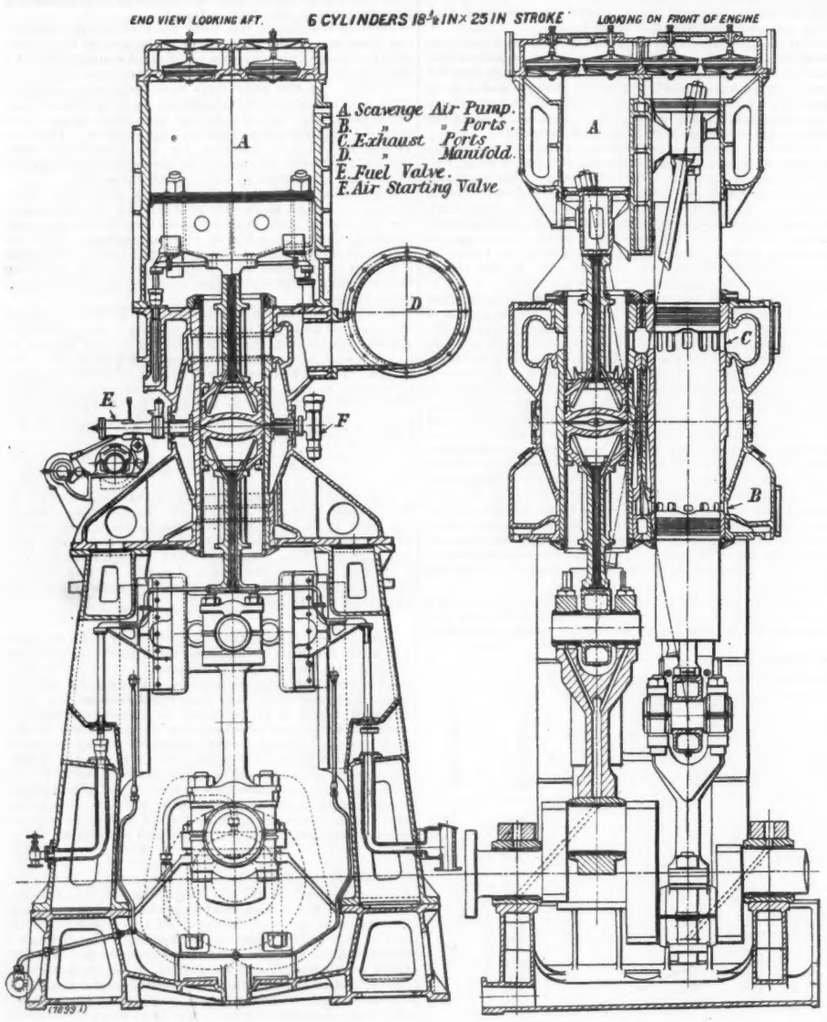
Scavenging air enters by the lower ring, and the exhaust gases escape by the upper ring of ports. During this period compression has been taking place in the other cylinder, and the oil is injected and combustion started, while the burnt gases in the left-hand cylinder are being exhausted. The engine thus works on the two-stroke cycle, and each crank receives two impulses per revolution.

During each stroke, side thrusts are produced by the oblique rods and these thrusts are taken by the crossheads attached to the pistons. It will be noticed that the upper crossheads are covered in and made to act as pistons for the scavenging pumps. Although rectangular pistons are somewhat unusual, the combination is an attractive feature of the design, and the scavenging pumps thus constructed are well adapted for their duties.

There are many attractive features about this design of engine. There are no cylinder covers with their attendant difficulties of high-pressure joints and temperature stresses. There are also none of the vertical stresses that exist in the framing of the ordinary engine, since the high pressure generated between any pair of pistons during combustion is taken entirely by the moving steel parts, such as crossheads, oblique rods, connecting rods, and crank shafts. The fluid pressure in each cylinder acts at every moment equally on the two cranks, so that the main bearings are relieved of a large proportion of the load. The action during the working stroke of driving apart the two pistons in one cylinder also produces compression in the adjacent cylinder by drawing together its two pistons by means of the oblique rods. Thus the negative work of compression is performed, not through the crank and connecting rods, but directly through the oblique rods. Only the net useful work is thus transmitted to the crankshaft. Due to the absence of cylinder covers, stresses due to temperature differences are confined mainly to the pistons and liners. Fig. 9 shows that the liner is a plain tube supported at each end, but free to move axially and surrounded by water. Temperature stresses in such a design are due almost entirely to temperature variations round any particular section and axial variation has little effect. Care has been taken to make the liner as symmetrical as possible, and in the combustion portion there are only two holes at the opposite ends of a diameter. One hole is for the fuel valve and the other for the starting valve.

Experience at sea has been gained already with this type of engine. In 1921 the Malia was engined by Messrs. David Rowan and Co., although the engines had been actually made by Messrs. Cammell Laird and Co., of Birkenhead. The fact that they are now proceeding with the construction of a larger engine of the same type would indicate their satisfaction with the results of the ocean experience of the Malia.

*The Scott-Still Engine.*—Messrs. Scott's Shipbuilding and Engineering Company, Limited, of Greenock, had an arrangement so far back as 1908 with the F.I.A.T. Company, Italy, for the manufacture of marine oil




FIGS. 9 AND 10. CAMELLAIRD-FULLAGAR DIESEL ENGINE.

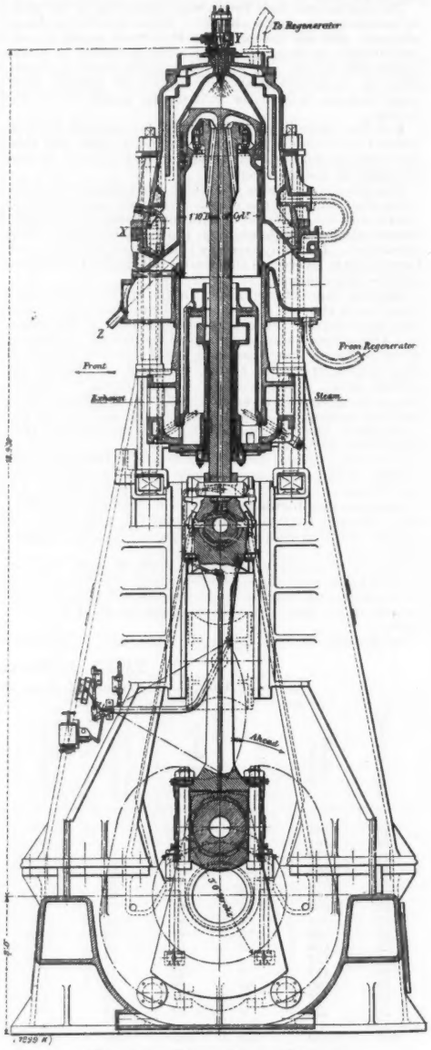



FIG. 11. SCOTT-STILL ENGINE.

* Paper read before the Institution of Mechanical Engineers at Glasgow, June 27, 1923.

engines of their type. Since then they have made for the British Admiralty four submarines and one oil-carrying vessel, all twin screws of powers varying from 450 b.h.p. to 1,060 b.h.p. fitted with Scott-Fiat engines. Several novel features were introduced with these submarine engines, chief among which was the capacity for reversibility. Submarines previously built could go astern only by declutching the main oil engines and running the electric motors, but with the reversible engine introduced by Messrs. Scott the operation of going from full ahead to full astern occupied less than 10 seconds. The progressive policy adopted by the firm is shown by subsequent events. In 1917 a licence was obtained from the Engine Development Company, Limited, London (now the Still Engine Company, Limited), for the manufacture of the type of oil engine invented by Mr. Joseph Still, and since then they have been engaged continuously in its further development.

The Still engine is a heavy-oil engine, the fundamental principle in which is the recovery of that heat which, in other engines, is given up to the cooling water and rejected in the exhaust gases, and its utilisation in the engine itself for the development of power. This is accomplished by raising steam as follows: (1) From heat taken up by the water circulating in the cylinder jacket under the pressure of the working steam; (2) through heat recovered from the exhaust gases by means of regenerators and feed-water heaters. In the exhaust-gas heater, the feed water is raised to boiler temperature, and in the cylinder jacket this water is converted into steam. The engine becomes, therefore, a combined internal-combustion and steam engine, and may be applied either as a gas or oil engine to any case where power is required and liquid or gaseous fuel is available. In the engine developed by Messrs. Scott each cylinder contains a single piston, the top or combustion side of which works on the two-stroke port scavenging principle, with mechanical injection for the fuel oil. On the bottom side steam operates as in the ordinary single-acting steam engine. Each unit thus becomes a double-acting engine with the limitation, however, that the power developed on the steam side of the piston is much less than that developed on the combustion side. It will be noticed also that the working steam performs the function of cooling the piston, usually served by a special circulation of water or oil. The heat thus extracted tends to superheat the steam and so increases the efficiency of its cycle of operations. Before placing an engine with such special features upon the market, the makers felt that it would be necessary to carry out a large amount of experimental work, and, in consequence, it was decided to make a preliminary investigation upon a single-cylinder engine of such a size that it would give information that might be applied directly to practice. The object aimed at was to produce an engine of such dimensions that a range of power varying from about 700 b.h.p. to 7,000 b.h.p. might be covered with single or twin screws, and a reasonable number of cylinders. The size of unit finally selected was a cylinder 22 in. diameter with 36 in. stroke, which, when running at 120 r.p.m., was estimated to develop a brake horse-power of from 350 to 400. A sectional view of this experimental engine is shown in Fig. 11, where the many noteworthy features associated with its design will be recognised. The combustion cylinder is supported from the columns by four distance-pieces, through which large steel bolts are passed. The bolts have their upper ends secured to the so-called mantle of the cylinder, and their bottom ends to the upper part of the columns, and thus the combustion load is transmitted through the columns to the bedplate. The working liner is secured at the bottom of its length, and is thus free to adjust itself within the mantle, as changes of temperature are experienced. The liner itself is of special interest. It is of cast-iron only $\frac{5}{8}$ in. thick, and is provided with a large number of vertical ribs. The upper half is fitted with steel shrouds shrunk on, thus providing the strength necessary to resist the bursting pressure experienced during combustion. By this design not only are the stresses due to heat transmission reduced to a minimum, but a large amount of heating surface and a means of securing a definite path for the jacket water are also provided. The ordinary cylinder cover has also disappeared, and is replaced by the conical-shaped end into which the fuel-injection valve is fitted. Although the utilisation of the otherwise wasted heat results in a gain of economy, it is probable that the greatest advantage gained by the steam production is reflected in the simplicity of the starting and manœuvring arrangements. For such purposes no compressed air is required, and under these conditions the engine becomes really a steam engine with the flexibility associated with that class of machine. The high temperature of liner and piston permits also the use of low compression pressures, and firing is obtained with certainty with a normal compression of only 300 lb. per square inch.

So successful have been the shop experiments made with this cylinder that the firm have undertaken the construction of a set of twin-screw engines designed upon the same principle. These engines, which are capable of developing 2,500 b.h.p., are being built to the order of Messrs. Alfred Holt and Co., Limited. Each engine consists of four cylinders of the same dimensions—22 in. diameter by 36 in. stroke—as the experimental unit and full power will be developed when running at 110 r.p.m. to 115 r.p.m. These engines will soon be ready for shop tests, and it is of interest to know that they will be submitted for testing to the Marine Oil Engine Trials Committee appointed jointly by this Institution and the Institution of Naval Architects.

*Sulzer Engines.*—The principal difficulties arising from the use of the two-stroke cycle are to be found in the increased stresses resulting from the large amount of heat that must be transmitted through the cylinder liner, cover, and piston. The manner in which these difficulties may be overcome by careful design is illustrated in the Sulzer Diesel engine. The general features of this engine will be observed in Fig. 12, where special attention should be directed to the manner in which the scavenge air is introduced to the cylinder. It will be noticed that there

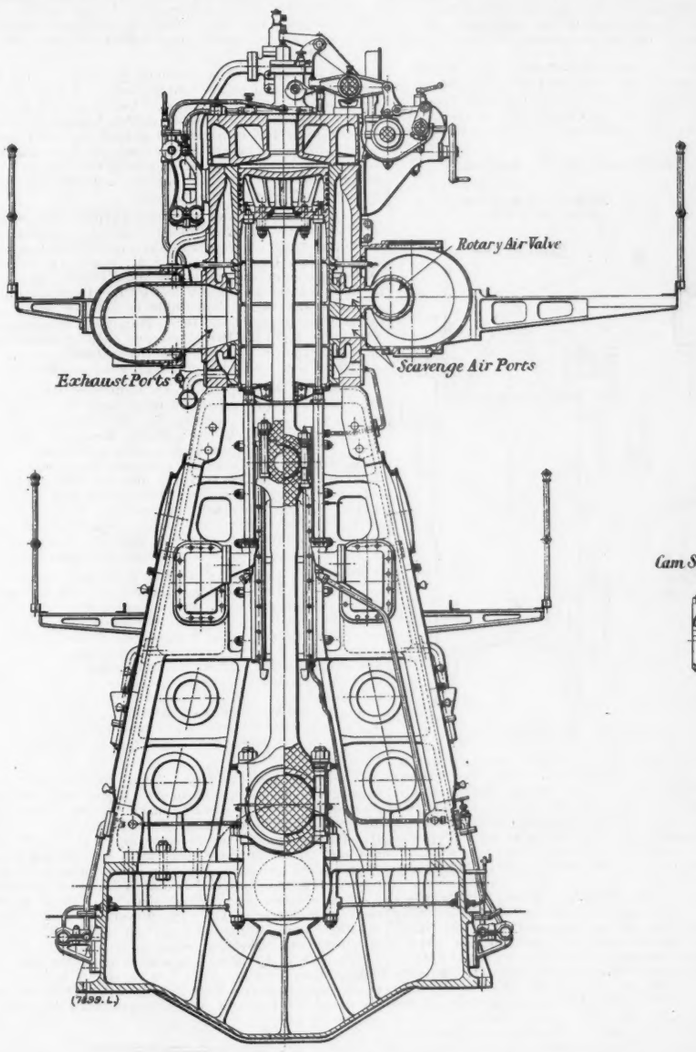



FIG. 12. SULZER TWO-CYCLE DIESEL ENGINE.

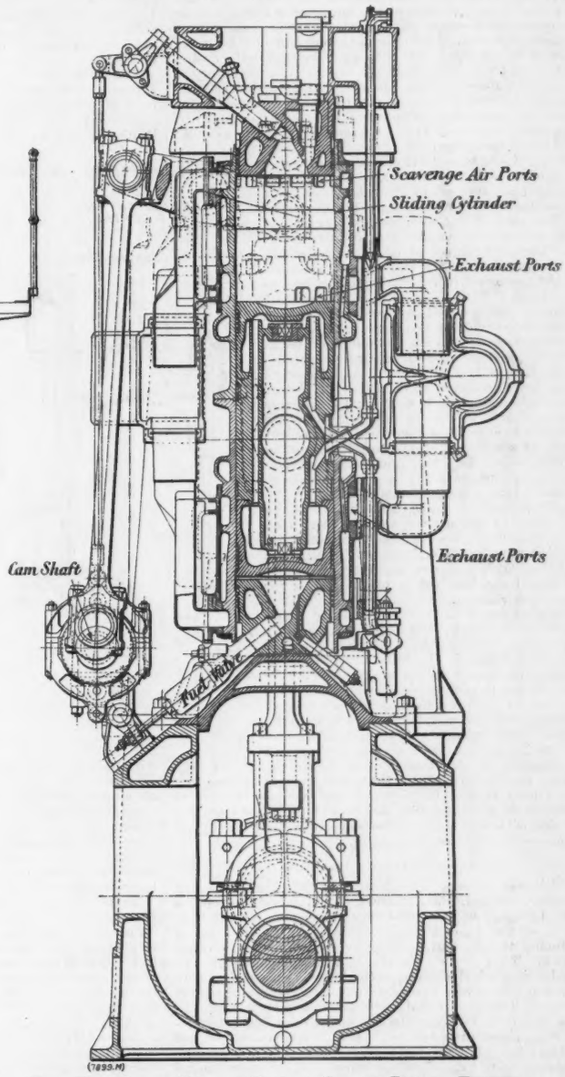


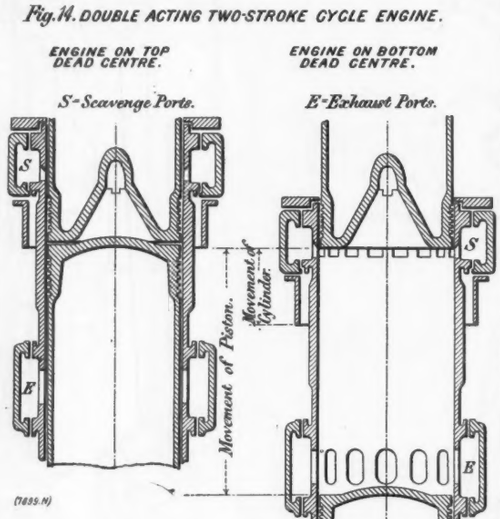

FIG. 13. NORTH BRITISH DOUBLE-ACTING DIESEL ENGINE.

are two rows of scavenge air ports, and that the communication between the top row and the scavenge air supply is opened or closed by a special valve. As the piston nears the bottom of its stroke it first uncovers the top row of ports, but as the air valve is then closed nothing happens until the exhaust ports on the opposite side are uncovered when the burnt gases commence to leave the cylinder. Shortly afterwards the piston uncovers the bottom row of scavenge ports and, as the pressure in the cylinder has now fallen, the scavenge air rushes in and helps to drive out the products of combustion. During this period the air valve is opened so that air is entering through both rows of ports, and this continues until, during the up stroke, the piston covers both the bottom and the top rows. The admission of air through the upper ports while the exhaust ports are closed ensures that the cylinder receives a full supply of air with the consequent possibility of a high mean effective pressure as illustrated by the curve in Fig. 2, page 95 *ante*.

The improvements resulting from the adoption of this port scavenging in place of the old system where the air was admitted through valves in the cylinder cover will be at once apparent. The cylinder cover can now be made of most simple form with only one opening for the casing containing the fuel and starting valves. The possibility of obtaining efficient cooling in such a symmetrical casting reduces the risk of excessive heat stresses in the cylinder cover to a minimum. The valve gear also becomes much simplified, and since the air admission valve is working in a comparatively cool place, it has been found possible to make it of the rotary type. This not only permits of a simple driving arrangement but offers special facilities for easy adjustment for reversing. The details of cooling and lubrication systems, and the arrangements for manœuvring and reversing, have been the subject of much careful study and experiment, and should be closely studied by all interested in internal-combustion engine design.

The confidence felt by local engineers in this type of engine is shown by the large number of firms who have taken out licences from Messrs. Sulzer Brothers for its construction. Messrs. William Denny and Brothers have been licencees since 1913 for Sulzer two-stroke engines, but owing to the war were not able to devote themselves to its manufacture until a comparatively recent date. A small twin-screw vessel was put in hand by them in 1914, and at present they are completing another twin-screw set capable of developing a total of 2,500 b.h.p. at 100 r.p.m. Messrs. Alex. Stephens and Sons have just sent to sea a twin-screw vessel fitted with Sulzer engines of their manufacture rated at 3,200 b.h.p., and Messrs. John Brown and Co., although not at present actually building have also taken out a licence for their construction. The most notable illustration of belief in the future of the Diesel engine is shown by the Union Steam Ship Company, of New Zealand, who have ordered from the Fairfield Shipbuilding and Engineering Company Sulzer engines for one of their large passenger vessels. This vessel will have four propellers, and each line of shafting will be coupled to a six-cylinder engine with cylinders 27½ in. in diameter by 39 in. stroke. Since each engine will be capable of developing about 3,250 b.h.p. at 125 r.p.m., it will be realised that the problem of adopting the Diesel engine to high-powered vessels is now in progress of solution, and the results obtained from sea service with this ship will be eagerly waited for by all interested in marine propulsion.

*Fig. 14. DOUBLE ACTING TWO-STROKE CYCLE ENGINE.*




### DOUBLE-ACTING ENGINES.

Although Messrs. The North British Diesel Engine Works, Limited, have turned out a large number of Diesel engines of the four-stroke single-acting type, they have, at the same time, recognised the possibilities of reducing weight and volume by the adoption of other cycles. They have, therefore, while engaged in the production of the more orthodox class, continuously devoted themselves to experiment with engines of special design. The most notable illustration of their action in this line is to be found in the two-stroke cycle double-acting engine, invented by Mr. J. Maclagan, an official of the firm. The general features of this engine may be gathered from Fig. 13, which represents an experimental unit which has now been put into service. The main feature of this engine is the open-ended cylinder which is free to reciprocate relatively to the two fixed covers provided at the top and bottom of the cylinder. These covers are fitted with spring rings so that a gastight joint is thus provided at each end along with freedom of axial motion. A double-acting piston reciprocates in the cylinder between the two fixed covers as shown. The absence of the usual piston rod should be noted as also the method of driving the crankshaft through a connecting rod coupled to a gudgeon pin. This gudgeon pin is attached to the piston and the ends project through axial slots provided in the walls of the cylinder. Crosshead guides on each end of the gudgeon pin serve to take up the side thrust introduced by the connecting rod.

The up-and-down motion of the cylinder is caused by the connecting rod and levers shown in the left of Fig. 13, and these, in their turn, receive motion from a crank attached to the camshaft shown. The air scavenge ports at the top and bottom of the liner are uncovered by the relative movement of the cylinder to the fixed covers. The exhaust ports are uncovered by the relative movement of the piston to the cylinder. The relative movements of the cylinder and piston are best shown in Fig. 14, where the comparatively small amount of motion given to the cylinder will be observed.

Many advantages are claimed for this type of engine. The elimination of the piston rod sweeps away many of the difficulties attached to the promotion of efficient combustion on the lower side of the piston. The simple form in which both the cylinder covers and the cylinder itself can be made reduces the possibilities of heat stresses, and the reduction in the relative velocity of the piston and cylinder will be favourable to the life of the piston rings. There will also be a great reduction in size and weight of engine and the makers estimate that a four-cylinder engine of this type will give the same power as 12 single-acting four-stroke cycle cylinders of the same diameter and stroke. The trials with this experimental engine proved so favourable that it was decided to proceed with the building of a large engine of similar design. This engine has three working cylinders, 24½ in. diameter with a stroke of 34 in., and is anticipated to give a sea service about 2,000 b.h.p. at 100 r.p.m. It is now in an advanced stage of construction, and it is anticipated that the members of the Institution will be able to examine it during the course of the Glasgow meeting.

The large variety of engines that have been described will serve to confirm the statement made in the early part of this paper about the many different types of marine oil engine that are now being built on the Clyde. While it may be taken that war conditions interfered with the development of this class of prime mover in Britain, it will be acknowledged that within recent times an amount of enterprise has been shown both by shipowners and engineers which should go far to place this country in a position in which we can take some pride. The policy of constructing and using so many types is certain to lead eventually to a favourable position from the point of view of actual experience, and its boldness is to be commended.

In the preparation of a paper such as this it is necessary to depend to a great extent upon the manufacturer for information and illustrations. The author would therefore, take this opportunity of expressing his thanks to builders of Diesel engines in the Clyde area, all of whom have responded in the most cordial fashion to his requests for assistance in the preparation of detailed accounts and for drawings to illustrate the features of their various engines. He would also express his gratitude to his colleague, Mr. John S. Brown, for the interest he has taken in the paper, and for the many helpful suggestions he made during its compilation.

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THE UNIVERSITY OF SHEFFIELD.—We are informed that at a recent meeting of the Council of the University the title of Emeritus Professor of Mechanical Engineering was conferred on Dr. W. Ripper in recognition of the services he has rendered to the Department of Engineering and to the University generally.

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THE POSITION OF SWEDISH INDUSTRIES.—According to statistics just made available, the iron, metal and machinery industry in Sweden has fared rather worse than other industries during the last two or three years of depression. For the companies included in the survey in question, which comprised the leading concerns, the aggregate balance shows a net deficit for 1922 of 54,100,000 kr. as compared with 61,800,000 kr. for 1921. For the industries as a whole, profits and losses seem to balance each other for 1922 whereas there was a net loss of 124,000,000 kr. in 1921. As many as 372 representative industrial undertakings, are included in the analysis to which we refer.

## CATALOGUES.

*Electric Condensers.*—The British Insulated and Helsby Cables Company, Limited, Prescot, Lancashire, send a copy of their catalogue of condensers for the improvement of power-factor, containing an explanation of the various losses involved by a low power factor and method of correction by condensers.

*Electric Machinery.*—The British Thomson-Houston Company, Limited, Rugby, send copies of a leaflet explaining the new British standard specification for the electrical performance of industrial motors and generators, and a new edition of their catalogue of air-break star-delta starting switches for three-phase squirrel-cage induction motors.

*Driving Chains.*—A few pages of notes on the selection of chain gear with formulæ and tables issued by Messrs. Hans Renold, Limited, Didsbury, Manchester, make a very concise reference book which every engineer responsible for plant design would find useful. The aim has been to provide reference matter free from advertisement, and we have no doubt that the result will be fully appreciated.

*Road Materials.*—A series of tar preparations for road making described in a catalogue received from Messrs. Thomas Hill-Jones, Limited, Bow Common-lane, London, E. 3, comprises materials for joining broken granite or granite sets, for dipping wood paving blocks before setting, for surfacing macadam roads, for spraying small broken granite, for treating granite or other stone at the quarry and also a special tar-free volatile constituent for application by spraying.

*Die Grinder.*—A small machine for grinding the cutters, or chasers, of screwing machine dieheads shown in a catalogue received from the Geometric Tool Company, New Haven, Connecticut, U.S.A., has a small round table capable of revolving and being tilted. The die is moved past the grinding wheel by hand against a fixed guide on the table. The table is compact and neatly made with graduations for setting to various angles. This varies from the British method of placing the chaser in a jig, which is so made that the surface to be ground is parallel with the table of the grinding machine.

*Induction Motors.*—Induction motors of the squirrel-cage and slip-ring types are dealt with in two special catalogues recently issued by the English Electric Company, Limited, Queen's House, Kingsway, London, W.C. One of the catalogues relates to motors of both types for general industrial purposes and ranging from 5 b.h.p. to over 600 b.h.p., while the other refers to totally-enclosed motors of the squirrel-cage type, for driving textile machines, and ranging from ¼ h.p. to 2½ h.p. In both cases the fullest particulars are given of the characteristics of the motor and the form and dimensions required for fitting and transporting.

*Stone Dust for Mines.*—It has now been made compulsory that in certain mines a fine dust of incombustible material, such as stone, shall be sprayed in the underground roads. This is the most effective way known of neutralising the explosive dust, which adheres permanently to the stone particles. A machine for pulverising to the fineness required, so that an air current of 800 ft. per minute will carry it distances up to a mile from the machine, is shown in a catalogue received from Messrs. Williams and Womersley, Wakefield. A 10-h.p. electric motor is a suitable drive. The machines are placed one at each large junction of roadways, or portable machines may be used.

*Wood-working Machinery.*—A very handsomely printed catalogue containing 140 quarto pages, with excellent illustrations of wood-working machinery, is to hand from Messrs. John Pickles and Son (Engineers), Limited, Hebden Bridge. The catalogue shows all the standard saw mill equipment and also ranges of machines for the special work, such as making boxes, wheels, wagons, casks, veneer, ply-woods, &c. The most noticeable features are the heavy single-piece main frame castings used throughout, the ingeniously-devised feeding, guiding and adjusting mechanisms, the excellent auxiliary machines for sharpening cutters, and the convenient and efficient portable machines for tree-felling, floor planing, &c. The catalogue is one of the most comprehensive of its kind issued by British manufacturers and it should materially assist the development of foreign trade.

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INSTITUTION OF ELECTRICAL ENGINEERS.—As a result of the recent ballot of the members of the Institution of Electrical Engineers, the following officers have been elected for the ensuing session: President, Dr. A. Russell; Vice President, Sir James Devonshire; Hon. Treasurer, Mr. P. D. Tuckett; Members of Council, Mr. J. M. Donaldson, Dr. W. M. Thornton, Col. T. F. Purves, Mr. G. W. Partridge, Mr. P. Rosling and Mr. S. W. Melsom.

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FRANCO-BELGIAN ENTERPRISE IN NORWAY.—The Compagnie Royale Asturienne des Mines, whose capital is principally French and Belgian, has for some time been negotiating with the banks which have taken over the Tysse falls regarding the purchase of the waterfalls, the power station at Tysse and the carbide factories at Odda. The company, it is understood, has offered to pay the debts of the Tysse concern, and the taxes, &c., due to the municipality, but in return it requires a very long concession, of some 80 years. The company produces zinc and should the deal be completed, of which there is every likelihood, production of zinc at Tysse will be taken up on a very large scale.